MACHINERY.

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THE WAY WORK IS DONE IN CINCINNATI.

NOTES GATHERED AMONG CINCINNATI SHOPS—A COLLECTION OF SHOP KINKS AND A DESCRIPTION OF METHODS WHICH ARE OF GENERAL INTEREST.

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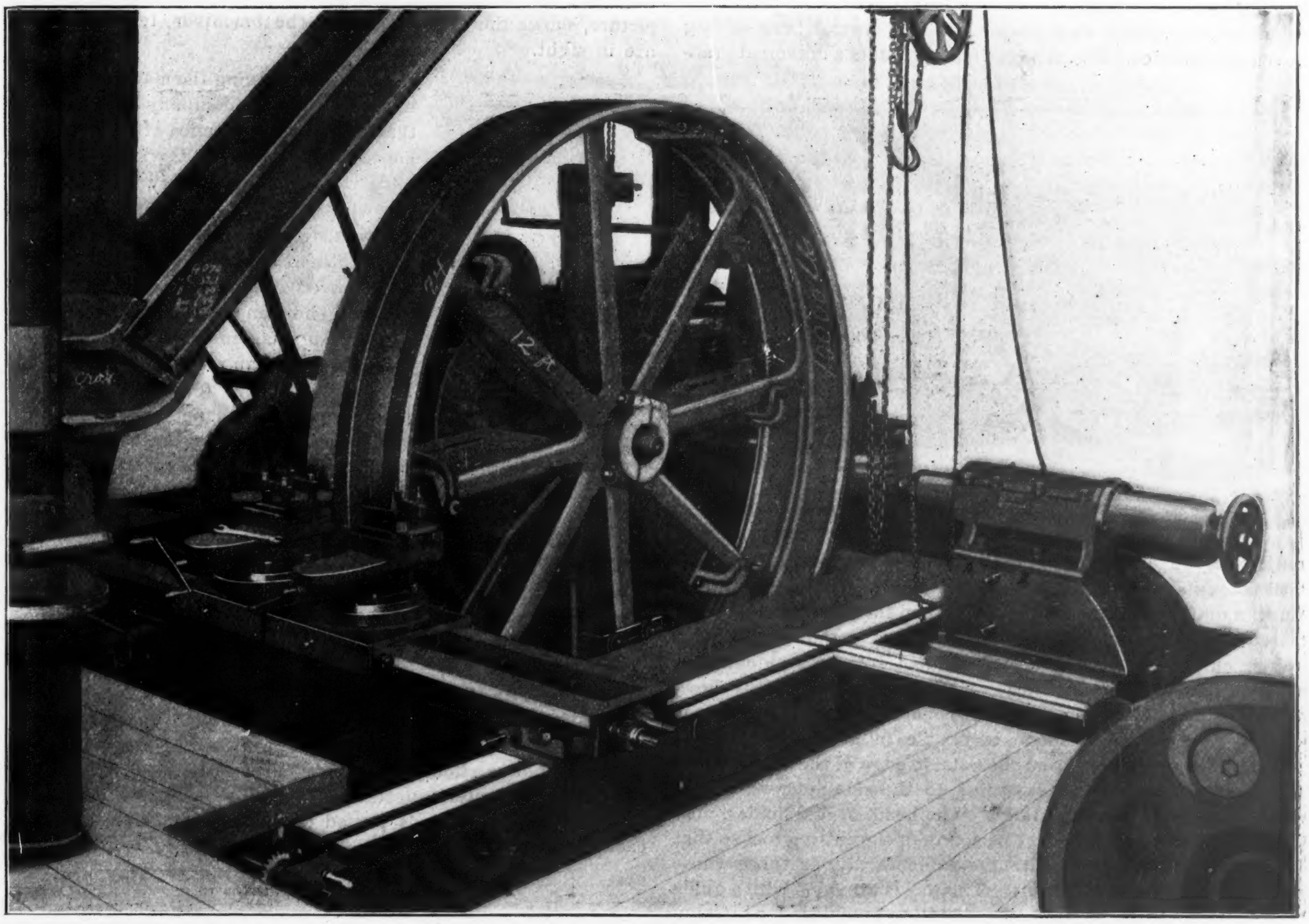
IT is a prevalent idea amongst the majority of Eastern engineers and mechanics that anything "Western" in the way of machine tools is equivalent to that which is rough, inaccurate, short lived, only fit to buy when the wherewithal is insufficient to procure a tool of better make; in fact, that little possessing real value in the line of metal working machinery can be found outside of the Eastern states. It is probable that many of these ideas date their origin to the appearance of Chordal's letters, written some twenty years ago, and at a time when the West, so far as tool building was concerned, no more resembled the West of to-day than the street cars we then had, resemble our modern time-saver, the trolley; but at present, the Western shops, judged by the standard fixed by those in the vicinity of Cincinnati, hold their own with the shops in any part of the world, and, in some particulars, are leaders in the procession, both as regards system and degree of excellence in workmanship.

THE CINCINNATI MILLING MACHINE CO.

The works of the Cincinnati Milling Machine Co. consist of a three-story brick building containing nearly 30 000 square feet of floor space, every inch of which is crowded to its fullest capacity. This company make nothing but milling machines and cutter grinders, which are turned out in sufficient quantities to keep about one hundred and forty men at work the year around.

One of the first points of interest that attracts a visitor's attention in passing through the shop is the casting storage room in which all castings are received from the foundry and assigned to certain specified localities as designated by symbols painted upon a continuous wall-bin, and upon sign-cards suspended from the ceiling, directly over the larger castings. This practice not only relieves the shop of all encumbrance in the shape of castings which are not needed, but enables the foreman to replace at once any defective piece that may be discovered in the course of erection, in which case, castings are ordered for stock, so that even lots will be on hand at all times to meet unexpected demands.



18-FOOT GLEASON PIT LATHE. SEE PAGE 109.

Opening out from this room we find another distinctive feature in the form of a paint shop in which five or six men do the painting for the entire establishment. The room is 70 ft. long by 20 ft. wide, and contains eleven side and five top windows, together with a 5 ft. by 7 ft. sky-light, which, with the light colored walls, give a better light than could be had anywhere else in the shop. The room is provided with a steam coil and two hot air pipes,

which are used in cool weather for forcing the heated air over the freshly painted work, and in hot weather for reducing the temperature of the room for the benefit of the workmen. In most establishments, the painter is found at work upon a machine standing in close proximity to others just completed, whose bearing surfaces receive their full quota of dust and grit thus set in motion, or is seen, can and brush in hand, wandering about the shop looking for his next job, which, in most cases, he is in no haste to find. At other times he is hidden away amongst a group of castings where solitude and insufficient light, combined with fond dreams of just such a work-shop as described, are conducive to an amount and grade of work that does little credit to either himself or his employer.

Adjoining each of these two rooms, is the stock storage room in which is found a centering and countersinking machine well worthy of notice. Instead of holding the work stationary as usual in chuck A, Fig. 1, page 116, a hinged, hollow spindle, head, fitted with a second chuck B, is fastened to the end of the bed by means of which the work is revolved during the operation, thus assuring true centering. For work of large diameter which will not pass through the spindle, two inches or over, head C is tipped back out of the way, thus permitting the piece to be centered to enter chuck A. Dropping the head into position and tightening both chucks, the jaws in A being used merely as a steady rest, the countersink is forced against the work to form a true starting point for the drill, which is then swung over into alignment, and the hole drilled, when the countersink is again brought into play, and the piece finished. The countersink is the old-fashioned square pointed kind and does not revolve.

Passing now to the shop proper, we find special labor-saving devices on all sides. Fig. 2, page 116, represents a universal graduating engine for cutting lines on milling machine dials. This tool takes in work from 2 inches to 14 inches diameter, and will finish a dial containing 300 graduations in three minutes, as compared with thirty minutes by the common method of using a rotary cutter, or a diamond-pointed tool--planer fashion, in a miller. The machine is built on a vertical plan in order to relieve the spindle of the strain incident to operating upon work that is out of balance, and is made reversible in action so that the graduations may be cut from the outside edge of the dial towards the center, or *vice versa*, according to the side upon which it is desired to have the long marks. The head, or dial holder, may be set at any angle to the line of action of the cutting tool so that bevel-faced dials are cut with the same facility as those whose faces are parallel to their axis. The tool is provided with a guide piece similar to those used on graduating machines for astronomical instruments, by means of which the cut may be regulated to the exact depth required. The machine makes one hundred strokes per minute, adjustable to any length, and will cut any number of graduations from one to three hundred and sixty by merely altering the throw of the connecting rod, or slipping on a different ratchet wheel. It is run by power for all work except segments which are usually done by hand power, a dial being provided on the top of the head to indicate the starting and stopping points.

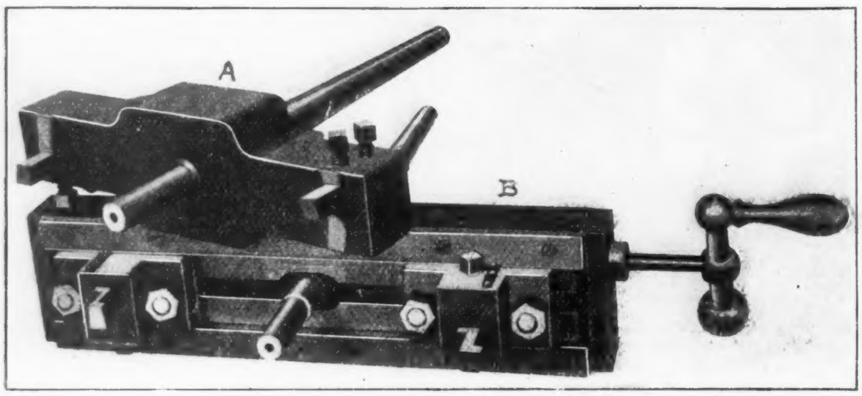


FIG. 3. T-SLOT TURNING TOOLS.

Fig. 3 shows a pair of lathe tools used for turning the T-slot in the cross slides on their milling machines. After the slide has been faced, the shank of tool A is inserted in the center of the tail-stock spindle, by means of which the tools are fed to the depth required, when tool B takes its place and completes the job. It will be noticed that the tools in B both point in the same direction, so that while one is turning the outside of the slot the other is at work on the inside; in other words the undercut for the bolt head is formed on either side of the center of the slot simultaneously.

In order that the tools may be adjusted to or from each other to suit the various diameters of work to be operated upon the tool holders are tongued and grooved with the slide, a finger, or pointer, on each holder indicating its proper position upon the same, which, as will be noticed, is graduated for six settings. A positive stop in the cross strip at the right regulates the depth of undercut, thereby eliminating the necessity for measuring. The upper, or first set of tools, are not adjustable, a different pair having to be provided for each diameter of ring.

In Fig. 4, page 116, is a device for chucking and cutting bevel gears. The gear is shown at A, and fits over a central stud fast in the body of the face of the plate, against which it is firmly clamped by means of a small screw in the end of the stud. The hub of the gear is let down into the jig, and in this way is well supported against the strain of the cut. A pointer, or rather stud, made V-shaped at the end, projects from the right side of the jig, and enables the operator to set the cutter central with the gear, after which the proper adjustment of the cross slide is made for the cuts, a separate index plate being used for each. The index pin seen at B is adjustable up and down to work in either plate, and makes it practically impossible to spoil a gear.

Fig. 5, page 116, is a partial view of the planer department looking down the center aisle, and though but an indifferently good picture, shows the arrangement of the machines, ten of which are in sight.

Anyone examining the machines manufactured by this company will notice that they make a practice of tapping the holes in the bases; and, without being told, would have difficulty in guessing for what purpose it is done. It is a common sight in most shops to see two or three men around a machine that is to be moved from one place to another, but here one man is all that is necessary to move any machine they make. Their trucks are made in the form of a U, and are provided with four screws which pass through and hang down from the side pieces. By backing one of the trucks up to a machine so as to straddle the frame, and entering the screws in the tapped holes, the machine is lifted and wheeled off in a moment.

As there are in Cincinnati something like one hundred and fifty machine shops, from nine of which I still have notes to present, it becomes necessary to defer greater detail of this interesting establishment to another writing.

THE DAVIS & EGAN MACHINE TOOL CO.

build almost everything included in a complete machine shop equipment, and with the new addition which they are just completing will have a floor capacity of 130,000 square feet. The first thing that the writer noticed upon entering the shop was a number of small, white labels pasted on the unfinished parts of the castings awaiting machining. These labels, Fig. 6, are put on

CHARGE ALL TIME ON THIS JOB TO		
2834	SCREW MACHINE LOT.	37

FIG. 6.

one of every lot of castings given out from the casting storage room—a room arranged very much after the order of the one at the Cincinnati Milling Machine Co.'s shop, but not so well lighted or conveniently located with regard to the subsequent handling of the work. The labels are printed in a number of forms worded to designate the respective lines of tools, *i. e.* "Milling Machine Lot," "Drill Press Lot," etc., each one being filled out with the order and lot number as shown above, thus enabling the workman to see at a glance to what number his time should be charged.

The next thing that attracted my attention was a handy little device used for graduating their planer saddles, by means of which a fairly bright boy can finish a saddle complete in less than ten minutes. Frame A, Fig. 7, is provided at one end with a boss, or hub, fitted to the center of the saddle around which it is moved, tooth by tooth, by means of lever B. With the right hand on this lever, and the left on lever C, which advances the tool over the work, the four short graduations are put on in a moment, when stop D is thrown back and the operation repeated,

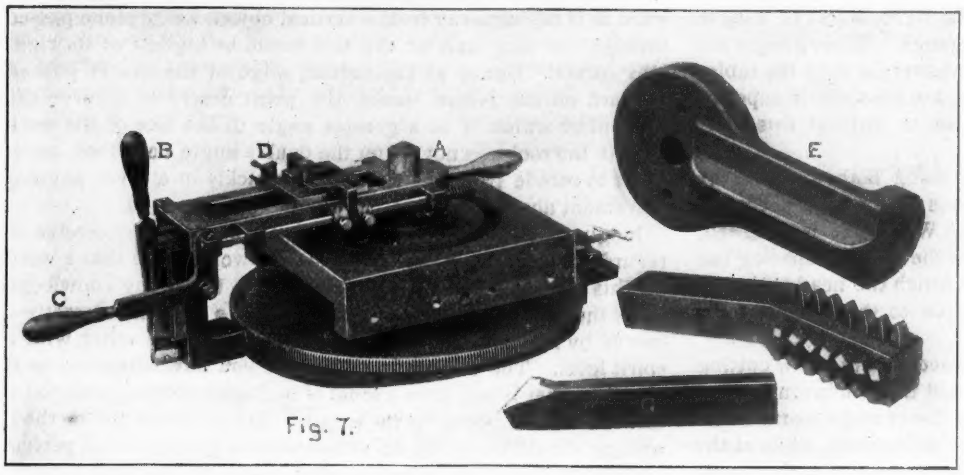


FIG. 7. DEVICE FOR GRADUATING PLANER SADDLES, AND TOOLS.

this stroke forming the long line. The tool carriage is adjustable to any part of the frame so that the graduations may be cut on any radius from the center. The depth of cut is regulated by a thumb-screw bearing against the face of the work slightly in advance of the tool. The device is also used with equal advantage for cutting their radial drill arms, in which case it is mounted on a knee, E, fitted to the end of the arm.

In the same figure we have a couple of planer tools of which they speak very highly. F is for roughing out the sides of their planer tables. The tool is first forced against the work broadside, then is fed down through a distance equal to the space between the tools, a sufficient number being used to cover the whole surface in this amount of movement. They are made right and left-handed and will finish a table in less than one sixth the time consumed by two single tools. The lower tool is used

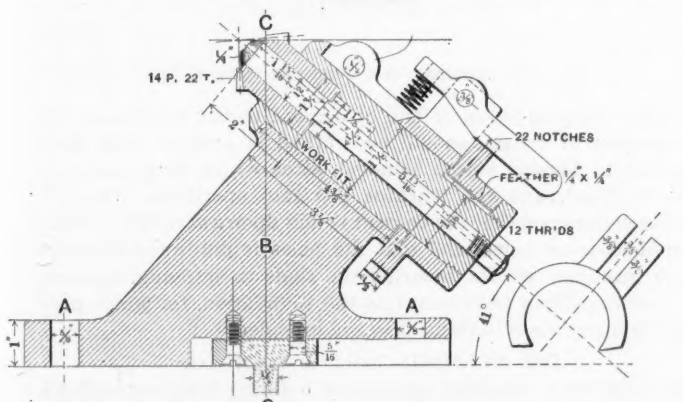


FIG. 8. BEVEL GEAR JIG.

for finishing the V's on their lathes, and takes a sheering cut the full width of the V. The surface left by this tool is nearly as smooth as one that has been scraped.

Fig. 8 shows the construction of another style of jig for cutting bevel gears and pinions which is intended to do away entirely, with all experimenting to find the proper "roll," or amount of "set-over," required by different work, and at the same time, to reduce the chance of error to a minimum. It consists of a work clamping bolt, a dial and locking device for indexing, a spindle for supporting the work as near the teeth as possible, a stand for fixing the angle, and a sole-plate, not shown, for securing the whole to the platen of a milling machine. A A are slotted holes to permit of stand B being swung upon its axis C C, about which it is moved, first one way and then the other, to suit the side angle of the teeth, stops being provided to fix the angle after once found. By using different spindles, dials, and clamping bolts, the same jig will answer for a number of gears.

This company make a practice of numbering all jigs and fixtures in rotation, each one being assigned a place in a series of cupboards built into the wall of the tool room, the doors of which upon being opened turn on an electric light. In no establishment that the writer has yet visited has he seen such an array of well kept tools—they almost remind one of some of the show cases at the Chicago Fair.

In Fig. 9 is shown two views of a reach tool which takes the place of the apron in the clapper box of a planer. It is very much stiffer than any tool holder that can be held in the tool straps, and, for many purposes, answers as well as a side head.

Another little kink practised by this company is the testing of forming tools by means of a bar of babbit, used in a form lathe like any ordinary stock. The scheme may be old to many, but heretofore I have always seen the tools hardened before being tried. By this method any inaccuracy is detected and corrected before the tool leaves the hands of the workman, which saves not a little time at the forge.

In the grinding-room they have a complete set of samples of all work done in this department. These are used to let the workmen see just what grade of work is expected of them. They are kept in wall cupboards provided with self-lighting electric lamps similar to those used in the jig closets. A buck-skin glove hangs on the inside of one of the double doors which, I take it, the men are supposed to put on in handling them. Each one has a cradle or pocket, to denote its particular place on the shelf, whereby it may be seen at a glance if any of the pieces are missing.

THE G. A. GRAY CO.,

builders of the widely known Gray planer, occupy three buildings, aggregating 30,000 square feet of floor space. It will be a surprise to many to learn that this company do no scraping on either the tables or beds of their machines with the object of bringing them to a bearing. The only scraping that is done at all being merely to remove the loose iron. There was a time,

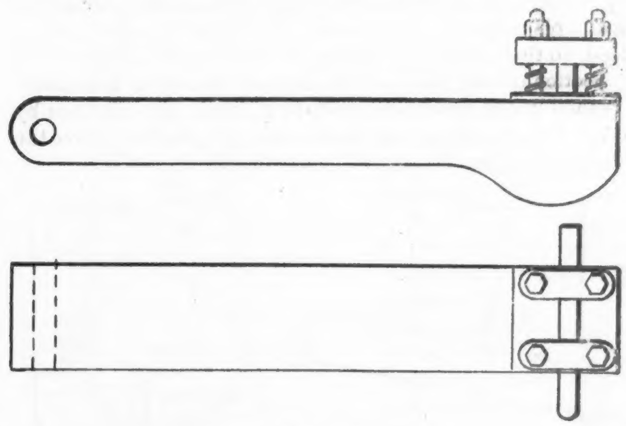


FIG. 9.

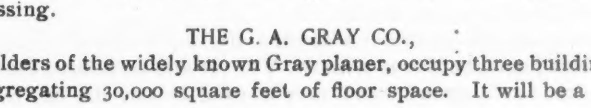


FIG. 12.

and not many years ago, when it was thought impossible to obtain a good bearing without doing more or less scraping, but with accurate tools, and some "know how," the scraping may be

entirely eliminated. One of the units in the "know how" is shown in Fig. 11, page 116, which illustrates their method of planing the V's. I hear some one asking: "What is the advantage of that; why is it not just as well to plane the corresponding angles in each of the V's—the common method, as to plane both sides of one V?" The kink is this: When two tools are at work upon opposite sides of the same V, each one resists the pressure transmitted to the work by the other, thus relieving the bed of the heavy stress incident to feeding both tools in the same direction. The result is that there is little or no spring in the bed, and the finishing tool has only the lightest sort of duty to perform in bringing it to a fit with the gauge. These gauges are made in the form shown in Fig. 12 and answer for both the tables and beds. The plan is not a new one, but is so vastly superior to the old male and female gauges as to warrant this brief mention.

Another advantage connected with using both tools in the same V is the ease with which the heads may be set in correct position for planing the remaining V. When one is roughed, it is only necessary to set a stop against the end of a spacing bar inserted between it and the head, after which the head is shifted against the stop which locates its position to the thickness of a paper.

In Fig. 13, page 116, is a view of a device used in screw cutting which is popular in the West. It is an old English invention and consists of a short shaft carrying on its lower end a worm-wheel which engages with the threads of the lead screw, while at the other end there is a graduated dial by means of which the operator can see at a glance when the screw is in the right position for closing the nut. This, however, is not its only recommendation, as any lathe thus equipped permits of the carriage being run back by hand without fear of clamping the screw in the wrong place when the cut is again started. The device is easily and cheaply made and may be attached to any screw-cutting lathe. It is, of course, obvious that the number of teeth in the worm-wheel must be some multiple of the pitch of the screw, and the number of graduations on the dial must equal the quotient obtained by dividing the number of teeth in the worm-wheel by the threads per inch of the screw. For instance: If the screw is 4 per inch, the worm-wheel can have 24, 28 or 32 teeth, in which case the dial would contain 6, 7, or 8 divisions, according to which of the above numbers are used.

Fig. 14, page 116, illustrates a simple and cheap means of facing the ends of planer beds true with the V's. It will be noticed that the device is so designed that it may be used on any size bed by merely inserting a different matching block between the cutter frame and planer bed. The machine is further provided with a star feed, so that after it is started it requires no further attention. Sectional beds, faced in this manner, line up as accurately as if planed in one piece and are done at much less cost than by the older plan of planing. It is necessary, of course, to have the bed block up so that the arm will clear the floor.

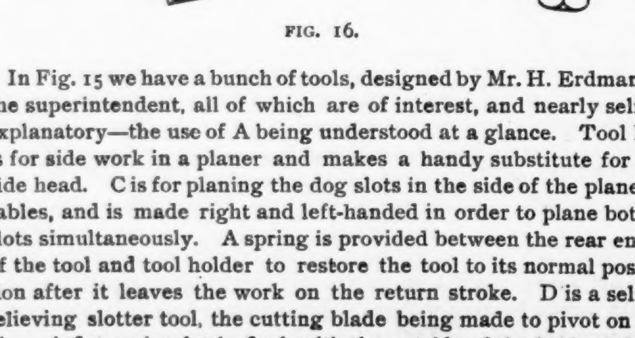


FIG. 16.

In Fig. 15 we have a bunch of tools, designed by Mr. H. Erdman, the superintendent, all of which are of interest, and nearly self-explanatory—the use of A being understood at a glance. Tool B is for side work in a planer and makes a handy substitute for a side head. C is for planing the dog slots in the side of the planer tables, and is made right and left-handed in order to plane both slots simultaneously. A spring is provided between the rear end of the tool and tool holder to restore the tool to its normal position after it leaves the work on the return stroke. D is a self-relieving slotter tool, the cutting blade being made to pivot on a pin. A flat spring let in flush with the outside of the back of the shank keeps the tool in position. E is a counterbore, the distinctive feature of which is the outer shell which acts as a depth gauge. It may be used with any size tit, the latter having a straight shank threaded at the end for removal when the teeth of the counterbore require regrinding. F is another self-relieving tool, used for under-cutting in a planer, and possesses a very desirable feature which is capable of wide adaptation, and is a wrinkle that should prove of value to planer hands generally. Referring to Fig. 16, above, it will be seen that the tool is not only set at an inclination lengthwise, but is also tipped slightly forward as if falling away from a vertical object, *i.e.*, a plane passed through the long axis of the tool would be highest at its right rear corner. Hence as the cutting edge of the tool is pushed forward on the return stroke, the point describes a curve the tangent of which is at a greater angle to the face of the work than if the tool was not set on the double angle described, causing it to recede from the work more quickly in a given angular movement about its supporting pivot.

Judging from the number of inquiries this company receive in regard to leveling up their machines, it would seem that a word on this subject would not be amiss. So far as my knowledge goes, there are but two ways of setting up a machine correctly—one is by means of a surveyor's transet, and the other with a spirit level. The former is all right if you have a transet, as is also the latter if you have a level of sufficient sensitiveness to indicate a tissue paper in its length. But whatever the method, wedges should be driven in at intervals of two feet until perfect alignment is secured, when a good grade of Portland cement,

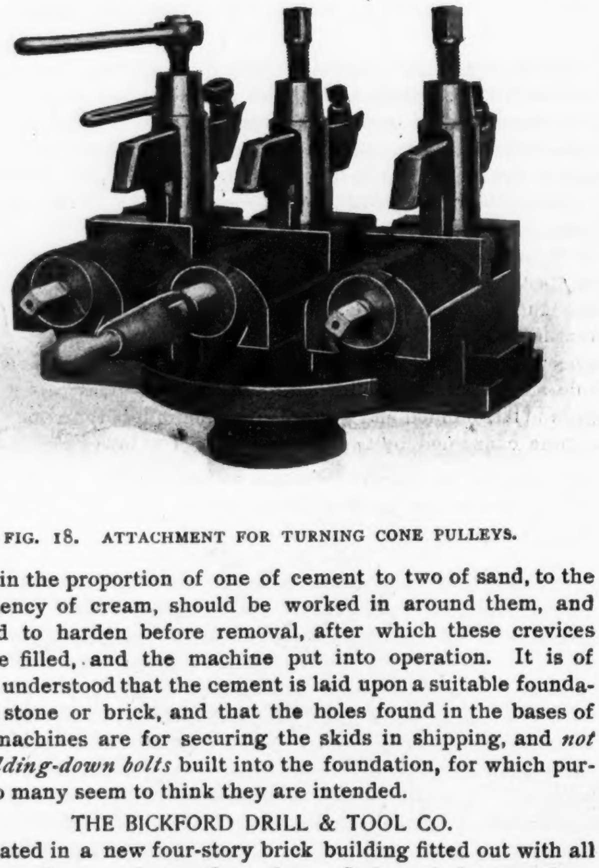


FIG. 18. ATTACHMENT FOR TURNING CONE PULLEYS.

mixed in the proportion of one of cement to two of sand, to the consistency of cream, should be worked in around them, and allowed to harden before removal, after which these crevices may be filled, and the machine put into operation. It is of course understood that the cement is laid upon a suitable foundation of stone or brick, and that the holes found in the bases of large machines are for securing the skids in shipping, and *not for holding-down bolts* built into the foundation, for which purpose so many seem to think they are intended.

THE BICKFORD DRILL & TOOL CO.

are located in a new four-story brick building fitted out with all the conveniences of a modern shop. It has windows on three sides and contains 23 000 square feet of floor space, all of which is devoted to the manufacture of drilling machinery.

This company will be recognized as the makers of the well known Bickford Radials, which tools formerly constituted their chief line of manufacture, but the constantly increasing demand for special machinery has lead them into the building of a large number of tools of which the machinery world hears little or nothing. One of their latest productions in this line, Fig. 17, page 117, is for boring four 5-inch taper holes simultaneously in cast iron boiler sections. The sections stand on edge between each pair of heads, in which position they are finished complete in less than two and one-half minutes. The machine weighs 8 000 pounds and was designed, all new patterns made, erected and shipped within six weeks of receipt of order, which furnishes a good illustration of Western hustle.

Fig. 18 shows an attachment for turning cone pulleys, three

steps at a time. It is made to bolt to the cross-slide of a lathe in the place of the regular compound rest and may be set at any angle to suit the taper formed by the successive steps. The cut is sufficiently clear to require no further explanation, although it should be stated that the round object under the rest is merely a collar to hold it in a horizontal position for photographing, and forms no part of the attachment.

In Fig. 19, page 117, we have a view of an ingenious arrangement for cutting dove-tail keyways in sleeve gears. The work is held in a V made fast to the ram head of a shaper by means of which it is carried forward and back over the stationary tool seen projecting through rod A. The knee is first fed vertically until the tool reaches its proper depth, when it is moved sidewise to form the under cut and produce the width of keyway required.

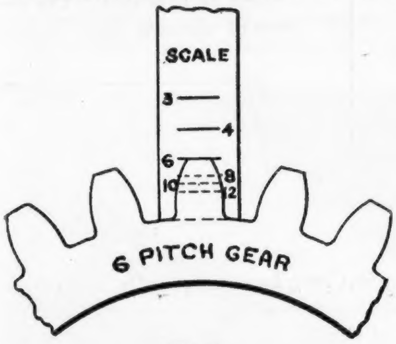


FIG. 20.

The superintendent of this company has a convenient little wrinkle in the shape of a scale for finding the diametrical pitch of gears without having to divide the number of teeth by the diameter. A series of lines are etched upon the end of the blank side of a 6-inch Brown & Sharpe flexible steel rule, each division representing the total depth of a certain pitch. By laying the scale against the side of a gear with its end flush with the bottom of the teeth, Fig. 20, the pitch is read at a glance.

The table of decimal equivalents shown below is another of his kinks, being arranged to read from the decimal to the fraction, or from the fraction to the decimal, with equal facility. These tables are ordinarily arranged in one of two ways, either by grouping all the fractions according to their denominators, as in the Brown & Sharpe Mfg. Co.'s "Practical Treatise on Gearing," or by placing the decimals in rotation as in the Garvin Machine Co.'s catalog. In the former plan, it is necessary to look under each group of fractions in order to find which is nearest to a certain decimal, when reading from the decimal to the fraction; and in the latter, it requires considerable looking around to find the fraction in order to read the decimal, each system being convenient for reading one way only, while in the following arrangement, the table is convenient for reading either way, an advantage not to be scoffed at.

DECIMAL EQUIVALENTS.

64	32	16	8	Decimal.	64	32	16	8	Decimal.
1				.015625	33				.515625
	1			.03125		17			.53125
3				.046875	35				.546875
		1		.0625			9		.5625
5				.078125	37				.578125
	3			.09375		19			.59375
7				.109375	39				.609375
			1	.125				5	.625
9				.140625	41				.640625
	5			.15625		21			.65625
11				.171875	43				.671875
		3		.1875			11		.6875
13				.203125	45				.703125
	7			.21875		23			.71875
15				.234375	47				.734375
			2	.25				6	.75
17				.265625	49				.765625
	9			.28125		25			.78125
19				.296875	51				.796875
		5		.3125			13		.8125
21				.328125	53				.828125
	11			.34375		27			.84375
23				.359375	55				.859375
			3	.375				7	.875
25				.390625	57				.890625
	13			.40625		29			.00625
27				.421875	59				.921875
		7		.4375			15		.9375
29				.453125	61				.953125
	15			.46875		31			.96875
31				.484375	63				.984375
			4	.5				8	One inch

Fig. 22 gives in outline the details of construction of a counterbore which may be made at less cost, and is more readily kept in order than those having the cutting teeth solid with the shank and the tits removable. In this tool it will be noticed that the tit is solid with the shank and the cutting shell detachable, the drive being effected by the projections on the shell, which are made a snug fit in the body of the shell.

Fig. 23 is a similar sketch of a ball-bearing cone center which is performing very useful service. The Bickford Company have a large number of spindle sleeves to turn which were formerly done by means of taper plugs driven in at the ends, but whenever the cores happen to be a little out of center it was necessary to

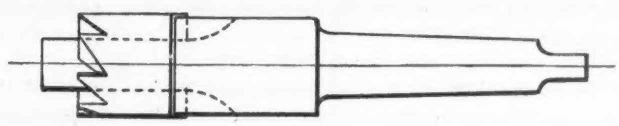


FIG. 22.

draw the center of the plugs to correspond, a process consuming considerably more time than to round off the edge of the hole on

FIG. 23.

the high side, which is all that is necessary in this case. The ball-bearing is introduced merely to lessen friction and save the center from undue wear.

THE J. A. FAY & EGAN CO.

are the oldest existing wood-working machinery manufacturers in the West, and one of the first of their kind in the country, the company having been founded sometime prior to the beginning of the war. The shops, three in all, each on a different and opposite corner, contain something like 12 acres of floor space, all of which is devoted to their one line of manufacture.

Considering the length of time the shops have been built, and that they were erected by two distinct companies, they are arranged very well, although one unaccustomed to dividing walls is liable to lose his way in the labyrinth of rooms and passages found on many of the floors. The offices are located in the second story of the middle building so that direct communication may be had, by means of bridges, with the shops on either side.

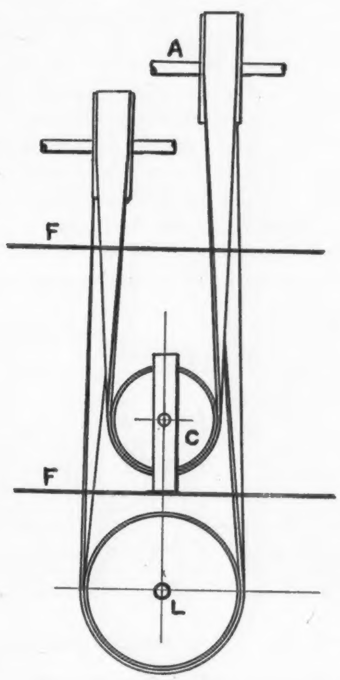


FIG. 24.

It may be of interest to know that Cincinnati was the first city to make furniture by machinery and, oddly enough, the concern was run by a colored man.

On the occasion of my visit to the Fay & Egan works, they were figuring with a concern in Russia to fit out a complete car building plant, capable of turning out 300 freight cars per day. When it is realized that the largest works in this country can only produce in the neighborhood of 50 cars a day, we can form an idea of the rapid strides which our brothers are making on the other side.

An amusing incident connected with this company's foreign business occurred at Johannesburg during the excitement of the Jameson raid. A large band mill on its way across the Transvaal was surrounded by an indignant band of Oom Paul's Boers who, mistaking it for a cannon, seized and placed it under arrest, afterwards holding a court of inquiry in order to determine the use of this strange looking object.

In the matter of shop kinks, this company is so reticent that I was unable to gather much of interest upon special tools and devices for cheapening production, but their Mr. Danner, who very kindly showed me through the works, pointed out a method of power transmission which could be used to advantage in any shop requiring to drive one line of shafting from another set at right angles.

F and F, Fig. 24, are the floor lines of the second and third floors, respectively. L is the line shafting on the first floor and A the shafting on the third, running at right angles as shown in

the sketch. C is a compensating idler so mounted in a guide frame as to be free to adjust itself vertically to suit the load. This plan does away with the obvious disadvantages connected with the use of a vertical quarter twist belt and is applicable to a large variety of cases.

R. K. LEBLOND.

makes a specialty of engine lathes, and in the course of their manufacture has gotten up a number of labor-saving devices among which is a machine for milling the faces of pulleys. This tool was described in the October issue, but is enough of a novelty to warrant an additional word. It is entirely automatic, the pulleys having but to be placed on and taken off the arbor. They are first roughed out—then finished, a fresh cutter head being

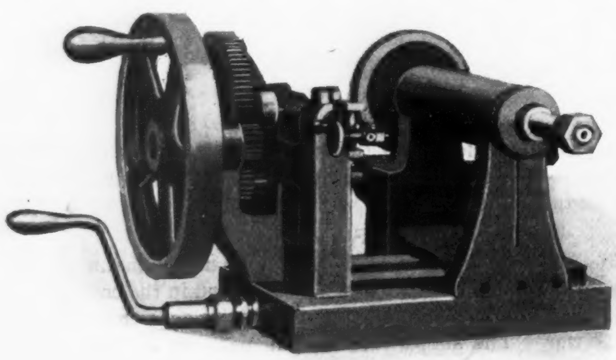


FIG. 25.

used for the second operation. In order to crown all pulleys central with their face, the machine is provided with a vertical adjustment, for bringing them into alignment with the cutter spindle and, by moving the head transversely upon its base, may be set to give any height of crown desired. The tool marks left on the finished work present a rather odd appearance, but the results are all that could be desired.

In Fig. 25 we have another form of graduating engine, used for putting the lines on the compound rests of their lathes. In general principle the design is similar to the machine made by the Cincinnati Milling Machine Company, but this tool is not adapted to cutting at an angle to the axis of the work head, and lacks a number of other advantages possessed by that tool. It is, however, admirably suited to the purpose for which it was intended, and enables the operator to finish a rest complete in less than three minutes.

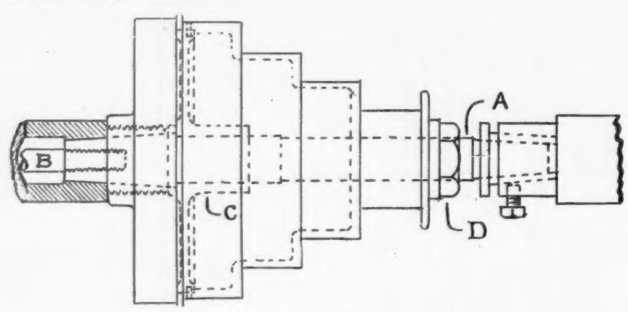


FIG. 27.

The lower of the two pinions seen at the left in the half-tone engages with a gear keyed to a shaft, carrying, at its other end, a crank arm, or disc, for driving a ratchet wheel made fast to the end of the worm-shaft, a small portion of which is seen near the center of the illustration. This shaft revolves the work spindle one degree for every stroke of the tool which is moved forward and back by means of a five-pointed cam on the back of the large gear operating against a roller held in position by a stud fitted in the cutter spindle. The machine originated with this company, and, I believe, antedates everything else of its kind in the West.

In order to lessen the chances of error in giving out drills from the tool room, and that the respective sizes may be found more readily, Mr. LeBlond has instituted the system of classifying the drills according to the denominators of the fractions representing the diameters, *i.e.*, all drills whose diameters are in 64ths are kept on one shelf, those in 32nds on the next, the 16ths on a third, and the 8ths and quarters on a fourth. Thus, if a 15-6 inch drill is wanted, the boy, or whoever is in charge, merely runs his hand along the 64ths shelf until he comes to the bin marked 15, all drills being found with the same facility.

THE LAIDLAW-DUNN-GORDON CO.

have their works at Tweedvale, a small country village, some six or seven miles distant from Cincinnati which may be reached either by rail or trolley. It is one of those modern, well arranged shops, which, of itself, bespeaks the success and prosperity of the owners.

This company make a specialty of pumping and hydraulic machinery, the demand for which has grown to such an extent as to warrant the erection of the new shop shown in

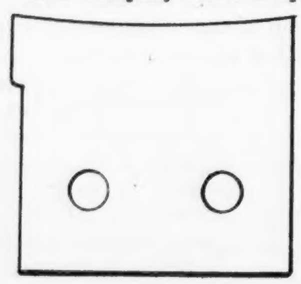


FIG. 28.

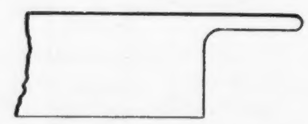


FIG. 32.

the illustration. It is 665 feet long by 113 feet wide, and contains approximately 100,000 square feet of floor space. With the exception of the office end of the building which consists of three floors and a loft, the shop has but one floor, a very good view of which is shown in Fig. 26. This picture was taken from the upper landing leading to the pattern shop, located on the second floor. It will be noticed that all the heavier tools are placed along the right side of the building, the idea in this being that as the castings are brought into the building from that side they may be machined while on their way across the shop to the drill presses and erectors on the left, an arrangement intended to reduce the cost of handling to a minimum.

In addition to the 15-ton electric crane seen in the foreground, the shop is provided on either side with a large number of air hoists, suspended from gib cranes set sufficiently close together to overlap. The line shafting for the small tools at the left receives its power from a motor, while that on the right is driven by an engine placed about midway in the length of the building.

The shop is heated on either side by a system of hot-air pipes which receive their heat from a chamber over the engine room. The air is forced through the pipes by two fans 9 feet in diameter by 4½ feet wide, which are driven by an independent engine in order that the temperature may be regulated at will.

A car track enters the building at one end, extending a sufficient distance to permit of loading three cars at a time. To the right of this track is the stock storage-room, which exhibits the same degree of thought in regard to arrangement as characterises the rest of this interesting establishment. The room is 65 feet

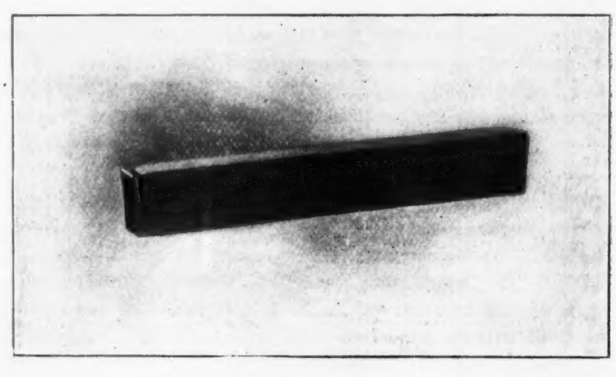


FIG. 31.

long by 46 feet wide, and contains six double and two side bins provided with fifteen shelves each, the upper ones being reached from a skeleton platform raised some six feet from the floor. These bins are 50 feet long, and are used for both finished and unfinished work. Each partition contains a card showing the number of pieces put in and taken out at various times.

To obtain a tool from the tool-room, the workmen have but to press a button near their vise or machine, boys being provided to do all running back and forth. Each connection rings up a

certain number in the tool-room, so the boys always know exactly where they are wanted.

Another admirable feature of this concern consists of two large fire-proof vaults, one of which is used for drawings and the other for office records. They are 14 feet square by about 10 feet high and are well lighted by electricity.

In the blue-printing room, I found a kink in the way of a simple method of determining when a drawing has been exposed a sufficient length of time. The scheme was put into practice before we had the present quick-acting paper, and has, no doubt, been the means of saving a great many yards of paper from being under or over exposed. The end of the frame nearest the window is carried out in the form of a shelf upon which a number of strips of paper are laid under a 10-inch by 10-inch glass. When it is thought the drawing has been out long enough, one of these strips is pulled out and washed, and if found all right the drawing is taken in, otherwise the boy waits a few moments and then washes another, until he finds one which shows a sufficient exposure.

THE LODGE & SHIPLEY MACHINE TOOL CO.

occupy a three-story building containing approximately 21,000 square feet of floor space, all of which is devoted to the manufacture of lathes and turret machinery. To the right as you enter the shop is a heavily geared 30 inch lathe, used for crowning cone pulleys with a forming tool made the full width of the cone face. The cone is mounted on a special mandrel A, Fig. 27, the large end of which is drawn tight in the live spindle by means of bolt B which passes through and is operated from the small end of the spindle, while the other end runs in a brass bushing fitted to the tail-stock spindle. C is the front bearing, or cone head, and forms the shoulder against which the cone is firmly held by nut D. The drive is effected by a projection on the face plate which engages with the notch for the locking nut. The tool, Fig. 28, is first moved sidewise against the side of the step to form the undercut, after which it is fed straight in, finishing the work in a very satisfactory manner. Some of the tools used for this purpose are as much as four inches in width.

Fig. 30, page 117, shows a universal scraping stand, which, as implied, can be set at any angle to suit the convenience of the workman. This extremely useful fixture originated with the Cincinnati Milling Machine Company, where its great utility has been so thoroughly demonstrated that it is rapidly being added to the equipment of all the tool shops throughout this section. Fig. 31 page 106, is a lathe tool for finishing pulleys, or other work, of large diameter. It is one of the neatest things of this kind that the writer has seen, and is so superior to the old fashioned goose-neck tool that he would recommend his friends to give it a trial. The tool is first drawn out to a point, as shown in Fig. 32, when it is hammered up into the position shown in the half-tone. With a ⅝-inch face it will stand a ⅜-inch feed without chattering in the slightest. On highly finished work, however, its advantage over the goose-neck tool is not so evident, the feed marks being less easily removed than those left by the finer feed of the latter tool.

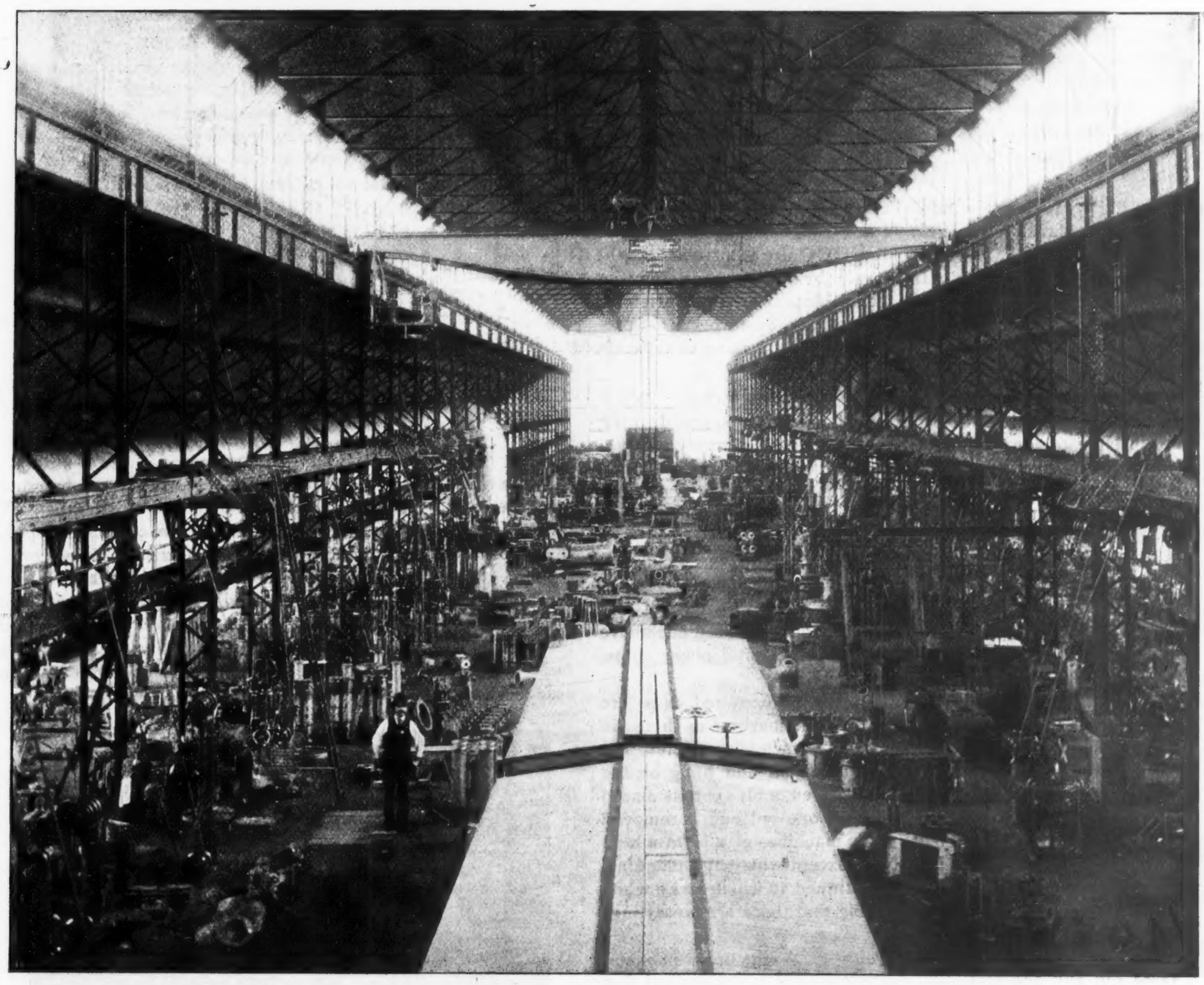


FIG. 26. WORKS OF LAIDLAW-DUNN-GORDON CO.

One of the customs in vogue in many of the tool shops in this section which strikes the Eastern men with more or less strangeness, is the system of making all small parts of machines from samples. After a new machine has been set up and thoroughly tested, it is taken apart, and the pieces placed in the sample room, subsequent lots being made entirely from these samples. To furnish an idea of the extent to which this system is carried by some firms, I might mention that the Lodge & Shipley Company have a cabinet in their purchasing department which contains samples of everything in the way of supplies that they use

about the place. In it are found samples of different grades of emery, sand paper, emery cloth, brass tubing, oil cups, center drills, countersinks, screws, monkey wrenches—in fact, one of nearly every standard article they purchase. These samples are tastefully grouped upon separate boards, each of which is assigned a certain shelf. The manufacturer's number is marked on each sample, and, if I am not mistaken, the page of the catalogue upon which it is found. The system is undoubtedly a great aid to the purchasing agent in making out his orders, but it is obvious that only such firms as make a limited line of machinery could well adopt it.

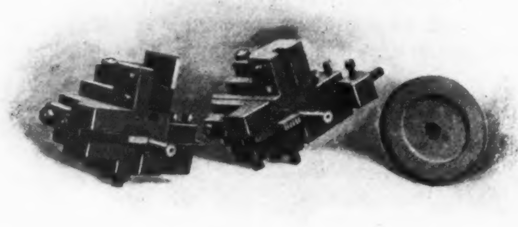


FIG. 33. TOOLS FOR BEVEL GEAR BLANKS.

In Fig. 33 is shown a pair of universal "jig-tools" for turning bevel gear blanks. The gear is first roughed with tool A, then finished by tool B. The tool holders C C C, are adjustable lengthwise on the central body D so that by merely changing the cutting tools the one pair of tools will answer for a variety of gears. They may be used to advantage wherever work is not produced in sufficient quantities to warrant the making of separate tools for each size of gear.

THE AMERICAN LAUNDRY MACHINERY CO.

have a shop of about 40,000 square feet of floor space, devoted exclusively to the manufacture of laundry machinery. Upon entering the office my attention was first called to a very unique system devised by their Mr. Rogers for keeping track of ordered work whereby it is seen at a glance just how many machines of each kind are in stock, how many are in course of erection, and how many orders are in hand waiting to be filled.

Fig. 34, page 117, represents a 30-inch by 38-inch board containing twice as many pins as there are sizes and styles of machines. Two pins are used for each machine, placed one above the other, on which are hung different colored poker chips, each of which convey certain information.

When an order is issued to the shop, as many red chips are placed upon the upper pin devoted to that machine as there are machines called for on the order, and as each is completed, and goes into stock, one of the chips is taken off and hung on the lower pin. For every order that is received, a blue chip is placed on the lower pin, which, together with one red one, is removed when the machine is shipped. If no machines of a certain kind are being made, the pin is left bare, except where the manufacture of that machine has been discontinued, in which case a white chip is hung on the upper pin showing that there are no castings in the house.

When a pair of pins have six red chips on the upper one, and three red and one blue one on the lower, it is understood that there are six of those machines being built in the shop, that there are three completed and in stock, and that one is sold, merely waiting to be shipped.

As a means of cutting down clerical labor, and at the same time keeping thoroughly posted concerning the status of every machine from the time it is ordered until shipped without having to turn over a page of a book, the system eclipses anything I have seen, and I think that manufacturers would do well to investigate the scheme at greater length.

In Fig. 35 is another board which is used in conjunction with the one just described. The numbers represent the several days of the month and are provided with hooks and clips for holding a copy of the orders that are expected to be filled on each of the dates. Similar boards are placed near the desks of the foremen in the different departments of the works upon which are hung duplicate orders, thus enabling them to see at a glance just what work is to be shipped on certain days. The chips on this board denote the Sundays and holidays.

In order that the superintendent may know when a machine is completed and upon what day it was shipped, and that the office may have a complete record of the purchasers of their product, the company use a form of tag illustrated in Fig. 36. As each order is sent into the shop it is accompanied by as many of these tags as there are machines called for in the order, and as each is finished the lower portion of the tag whose number corresponds with that machine is torn off at the perforation and returned to

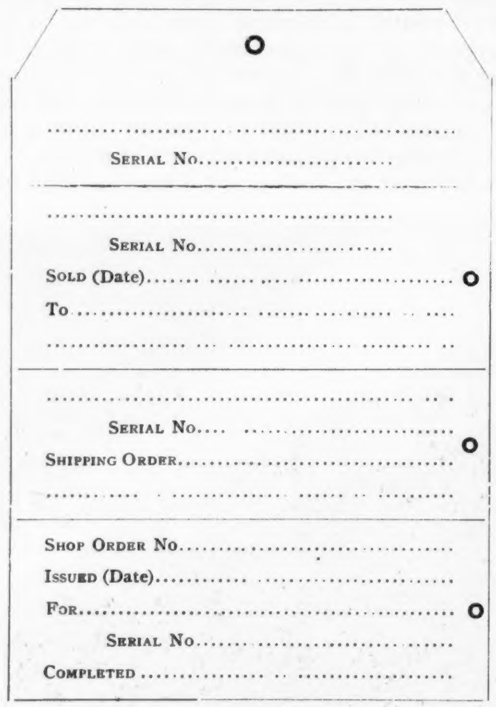


FIG. 36.

the superintendent. It is these tags which are seen hanging upon the stock board, Fig. 34, they being sometimes used on the lower pin instead of a red chip. When the machine is shipped, the second section is detached and also returned to the superintendent. The third section is for use where a machine is sold through any of the agents, the name of the purchaser and the date upon which the sale was made being filled in by them and returned to the main office. The upper section, or stub, is the buyer's record, and is intended for him to retain for reference in case he should ever wish to duplicate the order.

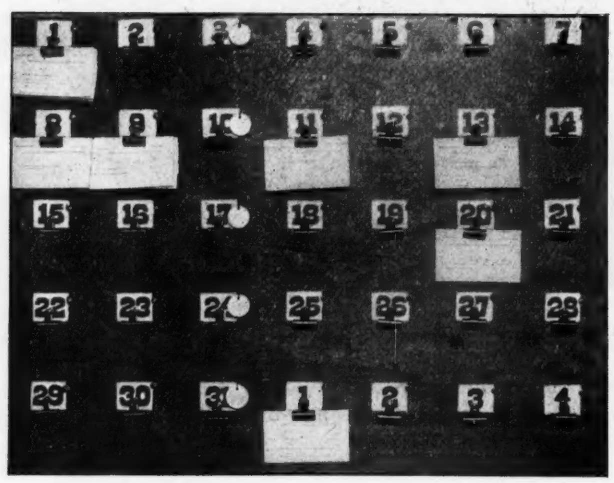


FIG. 35. ORDER BOARD.

The telephone system in use in this shop is another unique wrinkle devised by Mr. Rogers. When he took charge of the plant, there was a seven station speaking-tube line running through the various departments and offices in the works, but owing to the excessive lung power required to blow through the long tubes, and to make the whistles give any sound whatsoever, the line was seldom used. At first an elaborate telephone system was talked of, but instead of going to this expense, an electric bell line was run in series with a bell, push-button and battery.

placed at each station where the old whistles were located, by means of which any call is heard in every department—a feature of great desirability. Each push-button rings all the bells, and should a foreman be in any other than his own department when his call is given, he can answer at once. Should he be some distance away from the tube when his call is given, he gives a short ring as soon as he gets there, thus notifying the person calling that he is ready to listen, thereby saving the annoyance of one waiting with his ear to the tube. As the bell in the superintendent's office rings in unison with the rest, the superintendent always knows how closely the foremen are attending to their stations and work. The entire system was probably installed at a cost not exceeding twenty dollars.

In Fig. 37, page 117, we have a simple and cheap little device to hold an electric light in any position over a drawing board. It consists of but three pieces which may be whittled out by any body. The construction at the top forms a sort of ball and socket joint which permits the end of the arm to sweep the entire board.

HOUSTON, STANWOOD & GAMBLE

are a firm of engine builders located in a quaint old shop built in the early "fifties." In it I found one of the most noteworthy machine tools seen during my round of some thirty visits. It is an 18-foot pit lathe, built by the Gleason Tool Company from suggestions furnished by the Houston, Stanwood & Gamble Company. The machine weighs 60,000 pounds and takes in wheels up to 18 feet in diameter by 7-feet face, a 10,000 lb. wheel being shown in position on the first page of this issue. The wheels are turned and bored at the same time. The boring device was illustrated in a cut of this lathe which was published in this journal in May, 1896. The turning is done with four tools, two of which are used for facing the sides while the others are at work on the face. Wheels that are heavier than 10,000 lbs. are set in position, trammed true and bored while stationary, after which they are placed on a mandrel and turned between centers.

One of the excellent features of the machine is its wide adaptability, being arranged for turning a 36-inch pulley as economically as an 18-foot wheel. It is geared in the ratio of one hundred and sixty to one, and will take in 14-feet between centers which also makes it a very useful tool for boring large cylinders. By the use of a special slide-rest large sized cranks are trued up after being pressed on their shafts.

It is doubtful if there is another tool in this country of equal size that will do its work as economically from largest to smallest and will, at the same time, lend itself with such advantage to so many kinds of work.

AN OLD-TIMER.

In contrast to the modern appliances described in the foregoing paragraphs, is the lathe shown in Figs. 39 and 40, page 117. This curious antiquity is still holding its own and calling forth daily eulogies from the superintendent of the works in which I found it. The machine is used for facing columns and has an authenticated history dating back to the year 1832, at which time it had already seen a number of years of service. Referring first to Fig. 39, it will be noticed that the shears and rack are cast in one piece. These pieces vary from two to eight feet in length and are bolted to 10-inch by 14-inch wooden beams the cross-section of which is shown in Fig. 41. It is obvious that the carriage was, at one time, provided with a pinion, one-half of whose bearing is seen at the immediate left of the crow-bar which, at present, furnishes the carriage with its only means of locomotion, but in what manner the pinion was operated is more than I can even suggest, its cramped position on the carriage forbidding the use of anything but a ratchet wrench. The crow-bar is pointed at one end and has for its fulcrum the surface marked S in Fig. 41, into some parts of which it has been driven so many times that the ridge is nearly cut away.

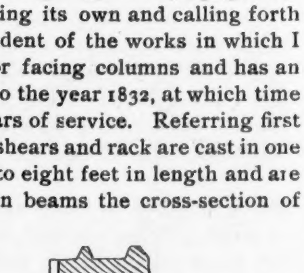


FIG. 41.

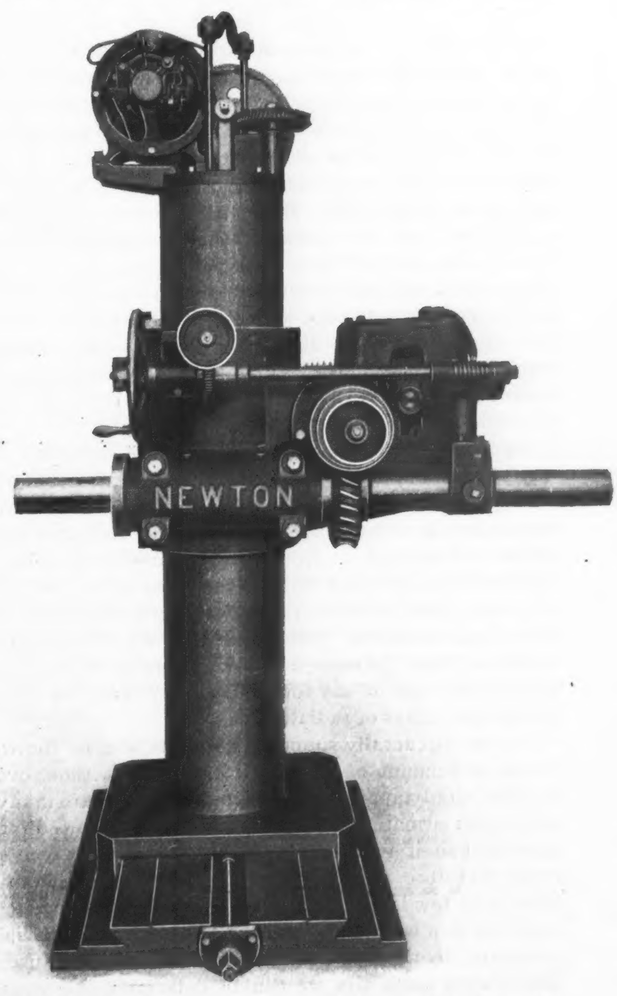
Another interesting feature in this lathe is the tool-post, Fig. 39, which will only permit the tool to be set at one of two angles. The slide is made with two rectangular holes passing through the adjacent sides in which a bar of iron, or old tool, is used to hold the tool-post in place. If the tool is to be used in the position shown in Fig. 39, the key is inserted in hole H. If it is to be set parallel with the shears, the key is put in the hole which extends through the slide lengthwise. And should the tool, by any possibility, require to be set at some angle between these positions, as in facing the ends of columns, a different post is used, the shank of which is twisted so as to give the desired angle between the tool and the key hole.

Fig. 40 is an enlarged view of the head-stock and shows the way in which the lathe is driven. The machine is started or stopped by means of lever L which pulls or pushes the driving gear D in or out of mesh with the spindle gear the teeth of which are still in fair condition.

In conclusion I wish to express my indebtedness for the courteous treatment received at the hands of the various gentlemen who so kindly showed me through their respective works.

PORTABLE BORING AND DRILLING MACHINE.

Electrically driven tools are of increasing interest at the present time, owing to the fact that shops are coming to use the electric motor more generally, especially for driving heavy and portable tools. In modern shops where the main floor is served by an electric traveling crane, capable of handling heavy machinery, portable tools of much greater weight and general utility can be used than formerly. The boring and drilling machine made by the Newton Machine Tool Works, of Philadelphia, and which is illustrated herewith, is of this nature. It is one of those tools which owes its existence to the modern traveling crane, and is of interest because the electric feature is car-



ried beyond the ordinary scope. One motor is used to drive the machine and feeds the boring bar; the small motor on the top of the machine is used for raising and lowering the head. A machine of this class, with the electric drive, reaches the highest point in efficiency for a portable machine, which must be shifted about and used on heavy work in the most convenient place. The machine is especially adapted for work on large dynamos or motors, as it can be set in any position on the floor convenient for drilling the large yokes, although it is also adapted to the manufacturing of heavy machinery of any class. The boring bar is four inches in diameter and is driven with a triple thread phosphor bronze worm wheel with a hardened steel worm.

HOW TO CALCULATE, DESIGN AND CONSTRUCT ELECTRICAL MACHINERY.—7.

Wm. Baxter, Jr.

The rules given in the preceding articles, together with the explanations, should be sufficient to enable any one to calculate the various parts of electrical machines, with the exception of the size of wire required for given capacities. To determine this point, all that is necessary is to know the relation between the amount of heat developed by the passage of the current through the wire, and the rate at which this is radiated from the surface of the machine when the temperature is not above that which is considered safe.

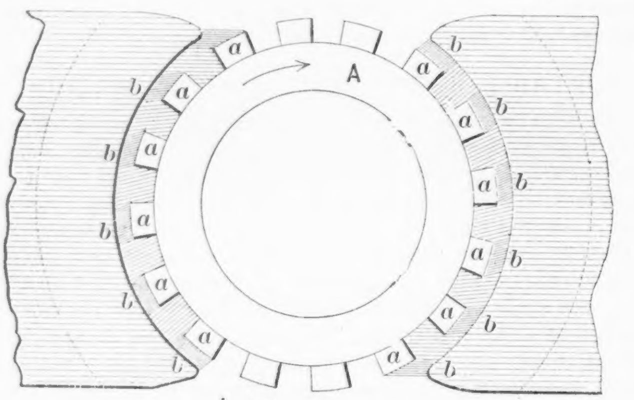


Fig. 42

A unit of heat is equal to about one forty-third part of a horse power, and is therefore equal to a little more than seventeen watts; that is, if the electrical energy absorbed in the passage of a current through a wire is about seventeen watts, the heat developed thereby will be about one unit. One unit of heat is that amount that will raise the temperature of one pound of water one degree Fahrenheit. By actual practice it has been ascertained that if the heat radiated from the surface of an armature is not over one half of a watt per square inch of surface, the temperature will not rise above the permissible limit. In the case of the field magnets, as these are stationary, and therefore do not get the benefit of the air currents that sweep over the armature in consequence of its motion, the radiation per inch of surface will not be as great; therefore three to four inches should be allowed to the watt.

To calculate the heat developed in the armature or field is very simple; suppose the machine delivers a current of one hundred amperes at an E. M. F. of 110 volts, if the armature resistance is as low as it should be, the voltage balanced thereby will not be over two volts. Now as the watts are the product of the volts by the amperes, it follows that two volts multiplied by 100 amperes equals 200 watts; therefore the armature surface should be 400 square inches. The loss in the field of the same machine would be about the same amount, and as the surface would have to be at the rate of say four inches per watt, we would require 800 square inches of radiating surface.

It is very generally supposed that the size of the wire determines the amount of current it can carry without overheating, but this is only approximately true. If there are many layers of wire on an armature, a larger wire will be required for the same current than if there are few, and the same is true of the field coils; therefore an effort should always be made to place the wire in as few layers as is possible. In making preliminary calculations it is best to determine the size of wire specially for the armature, by the average carrying capacity, because unless we decide upon some size we cannot determine the space required for it.

It is customary in such cases to assume that in the armature the wire will carry at the rate of one ampere for every six or seven circular mills of cross section, and the same figure may be used for field wire, in sizes larger than No. 10 B. & S. gauge. For sizes as small as No. 20, eight or ten circular mills to the ampere should be allowed. The circular mills for any size of wire can be obtained from tables given in catalogues of manufacturers.

In all that has been said it will be noticed that no general rule has been given whereby all the parts of a machine can be determined in their relative proportion to each other; there is really no such rule, and if there were, skill as a designer would count for little, as every one would obtain the same results, and the machines of all designers would be in the same proportion. Individual judgment must decide upon the relative proportion of the various parts, and these must be made with reference to the work they are expected to perform. It is here that the skillful designer displays his ability. All that the rules can do is to tell him what certain proportions will be, if he decides that others shall have given dimensions, and then it is for him to judge whether these proportions are the best or not. To illustrate this point, suppose you desire to design a motor of ten horse power capacity to run at 1 200 revolutions per minute, which equals 20 per second, with a current of 220 volts E. M. F., and suppose you decide that the armature shall have 200 turns of wire and that it shall be of the drum type, which will give it 400 wires on the outside surface. Then as the energy, ten HP., equals 7.460 watts, and the voltage is 220, the current will be 7 460 watts divided by 220 volts, or about 34 amperes, and as this passes through the armature in two circuits, the current in each will be 17 amperes. Allowing six mills per ampere we would require 102 mills, or say No. 10 B. & S, wire. This wire outside of the insulation will measure about eleven-hundredths of a inch, and can be laid on the armature at the rate of about eight turns to the inch of surface, or 25 inches if laid in one layer. This would be equivalent to a diameter of eight inches. Now multiplying the wires 400 by the revolutions 20, we get 8 000, which goes 12 500 in 100 000 000; therefore, 12 500 lines of force must be cut per second to give one volt. This number, 12 500, multiplied by 220 volts, gives 2 750 000 as the total number of lines of force required in the field, and dividing it by 40 000, we get about 69 as the number of square inches of surface for each pole. As the armature is eight inches diameter, we can call the width of the pole around the circle eight inches, and its length parallel with the shaft would, therefore, be about nine inches, which is a fair proportion. Having got this far we can ascertain what the resistance of the armature wire will be, and if it is too high we will have to either make the wire larger or the turns fewer. Before deciding which to do we should determine what the heat developed will be, and if it will be more than the armature can radiate without becoming too hot, we will be compelled to enlarge the wire and reduce the number of turns, but not change the diameter of the armature, or at least not in the same proportion. In this way we proceed until we believe the best proportions have been secured, and whether our conclusions are correct or not will depend upon our judgment.

The actual results will not be quite equal to those calculated, owing to the fact that there are certain losses that we have not made allowances for. What the most important of these losses are will be explained in the following.

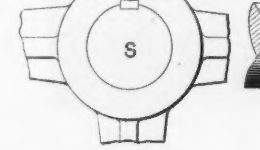


Fig. 43

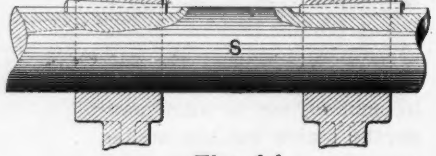


Fig. 44

In the field there is a loss known as eddy current loss; it can be explained by the aid of Fig. 42. This figure represents a grooved armature, with which the loss is the greatest; with smooth core armatures it amounts to so little that, ordinarily, no provision need be made to reduce it. In the grooved type, as the ends of the teeth are so much nearer to the pole surface than the bottom, nearly all the lines of force pass to them, and as the armature rotates, the lines are drawn around following the teeth. As the teeth pass from under the poles the lines are compelled

to break away from one tooth to the one back of it. This process causes the lines to sway back and forth in the pole pieces, and thereby to generate currents therein. To prevent this it is customary to either laminate the pole pieces or cut grooves in them at right angles with the shaft, and deep enough to prevent the circulation of eddy currents near the surface. Such grooves are indicated by the dotted lines in the cut. With smooth core armatures this loss is small, but is greater as the number of sections in the commutator is reduced. The cause of the loss with this type of armature is, that as the brush passes from one segment to another, the position of the current in the armature in relation to the pole pieces is shifted, and the fewer the segments the greater the displacement, and this causes a swaying of the lines of force, similar to that just explained, but to a less degree.

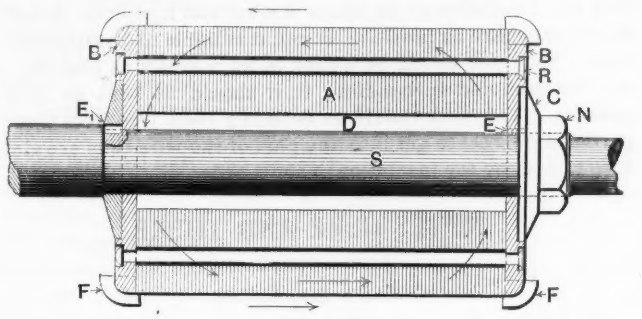


Fig. 45

Another loss is occasioned by currents in the core of the armature, as indicated in Figs. 43, 44 and 45, which represent two views of a ring armature and one of a drum. If the core A were made of one piece of iron, currents would circulate in it as shown by the arrows, since there would be nothing to prevent the induction therein to act as well as in the wire proper. To prevent this the cores are laminated, and the laminations are insulated with paper. In large ring armatures the side rings C should be made of iron, and the rivets D must be insulated from them as shown at E; if not, currents will circulate through the rivets. Small drum armatures can be made with core ends of hard fiber, and then this alone will afford the insulation of the rivets. The body of the rivets must also be insulated. Smooth cored armatures must have corner pieces F to prevent the wire from slipping when under the pulling strain of the magnetic force. The core must be separated from the shaft by wood or fiber, to prevent the lines of force from passing through the shaft and generating currents therein.

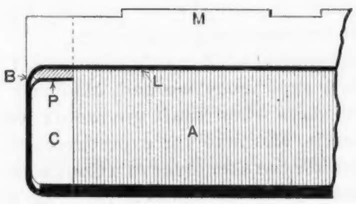


Fig. 46

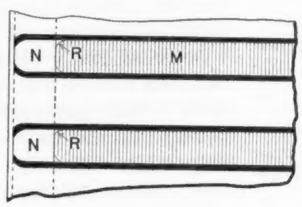


Fig. 47

As the poles in the armature remain fixed in space, it is evident that they travel through the iron, and at a velocity equal to that of the armature. As this rotation of the poles causes the metal to change its polarity very rapidly, it occasions a loss which is due to the fact that it requires a certain amount of time to vary the magnetism of iron. This loss is sometimes spoken of as due to what might be called magnetic friction. The term by which it is designated, however, is hysteresis. The slower the armature revolves and the lower the magnetic density, the less this loss is, but in any case it is not likely to go beyond two or three per cent., hence it will not affect the capacity of the machine to any great extent. Its principal effect is to increase the temperature of the armature, as the energy lost in this way is converted into heat. On this account, if the armature is to run at a very high velocity, or the lines of force per inch that will pass through it are to be very great, an extra allowance of radiating surface must be provided; if not, the machine will not be able to run up to its full capacity without danger of overheating.

Another direction in which a loss is suffered is in the leakage of the magnetic lines of force of the field through the air, without going through the armature. This always occurs, except in certain forms of machines that are more or less objectionable in other ways; but it can be made small by making the shape of the field magnets such that they come nearer to each other at the armature than at any other place.

The foregoing losses and several others of more or less importance, can be calculated with certainty in some instances, and with a fair degree of certainty in others, but it would be difficult and tedious to undertake to explain the rules in an elementary manner, and it is not really necessary, because knowing that they are to be provided for, a proper allowance can be made in the calculations. The armature can be calculated for a somewhat higher E. M. F. than is desired, and the field coil space can be made larger than is necessary to hold the wire supposed to be required; then there will be a lee way, so to speak, which will enable us to adjust the machine when made to operate just as desired.

With series wound machines, if the E. M. F. is too low or too high at the proper speed, it can be adjusted by adding or removing wire from the field coils. With shunt, and compound wound machines, it is best not to wind the field coils until the proper number of ampere turns has been ascertained experimentally. To accomplish this, make temporary coils of large wire and energize the field by a current derived from an independent source. In this way the number of ampere turns required can be found; then decide what percentage of the total output of the machine can be used to magnetize the field (it should not be over four per cent., unless the machine is very small). Knowing the total number of watts the machine will develope, the number that can be used in magnetizing the field can be ascertained by taking the desired percentage of the total, and this divided by the voltage will give the current in amperes. Knowing the strength of the field current, the total resistance of the coils can be found, as it is equal to the voltage divided by the current. The length of a turn on the coils can be found by actual measurement, and from the strength of the current the number of turns necessary to give the proper ampere turns can also be found; hence, the number of feet of wire can be ascertained. Look in a table of resistances and find what size wire will give this number of feet with the resistance required, and use this size wire for the shunt coils. The number of turns in the series coils can be ascertained by finding out how many additional ampere turns must be added to the field to develope, at full load, the E. M. F. desired.

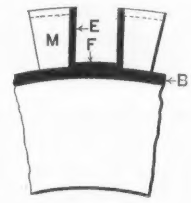


Fig. 48

It should not be supposed that the study of the principles and rules given in these articles will enable any one to become an expert designer of electrical machinery. The subject is a very extensive one, and could not possibly be presented in anything more than a superficial manner in such a short space, and only the more elementary parts thereof have been explained; but what has been given is sufficient to enable any one to design machinery that will compare favorably with a great deal of that now on the market.

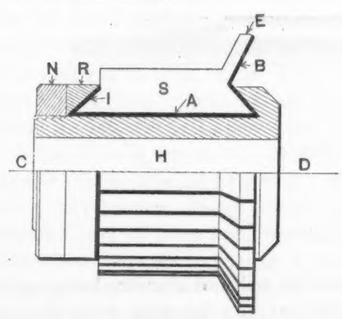


Fig. 49

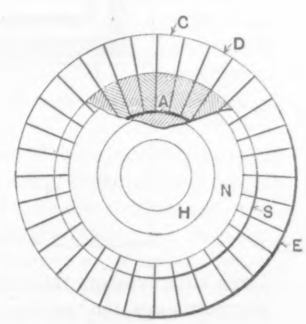


Fig. 50

We will bring the subject to a close by giving a few explanations of the principal constructive features, not already explained.

In addition to what has been said in connection with armatures it may be added that the cores must be well secured to the shaft. This can be accomplished, in the drum type, by means of feather keys, as shown at E, Fig. 45, and washer C and nut N. This holds the armature as a whole from turning, and the rivets R prevent the core A from slipping around between the heads B.

Ring armatures are held in place by some kind of spider, as

shown at F, Figs. 43 and 44. If the machine has six or more poles, the spiders may be made of steel, providing the number of arms is equal to one half the pole; if not they must be made of brass, or they will afford a path over which the magnetism will leak.

In insulating grooved armatures it is necessary to guard against the possibility of the wire cutting through the insulation where it passes or turns around sharp corners. See Figs. 46, 47 and 48. For this purpose it is well to make the end rings C smaller than the body of the armature core, so as to be able to place an extra insulation as at P. To guard against cutting into the corners R of the teeth, these should be filed off round and a block of hard wood or fiber N should be placed in front of them to hold the insulation against the pressure of the wire. The bottom insulation F, Fig. 48, should be the full width of

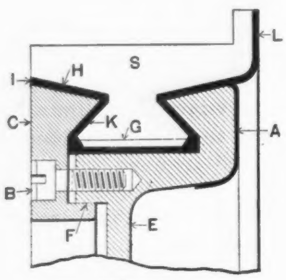


Fig. 51

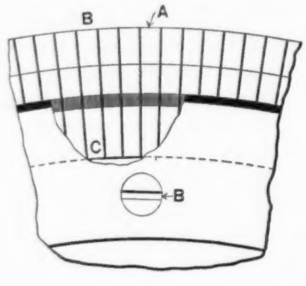


Fig. 52

the groove, and the sides E should rest upon it so as to guard against the wire slipping through the crack and coming in contact with the iron. It is better, however, to make the insulation in one piece, in the form of a trough. Mica covered with linen is the best material to use.

The top of the teeth should be turned down to a smaller diameter where the wire bands that hold the wire in place are applied, so that when the bearings wear down to a point where the armature can touch the lower pole pieces, the bands will not be the first to strike.

The commutators require considerable attention to make them substantial, especially if large. Figs. 49 and 50 show the construction for small sizes. In these figures it will be seen that the segments S are held in place by the pressure of the ring R and nut N against the bevel ends I. This gives a solid support, when the diameter is small, because the segments are decidedly wedge shape, as can be seen from Fig. 50 at C and A. With

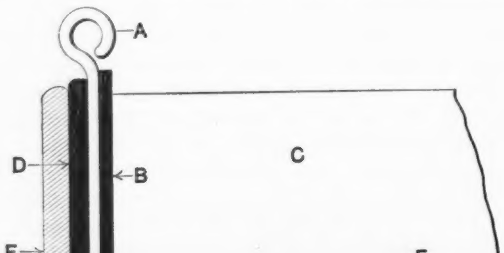


Fig. 53

large commutators this construction will not answer, because the segments are too nearly parallel, as can be seen from Fig. 52, where C B are but slightly different. To make such a commutator solid, it is necessary to hold the segments from moving in, as well as out, and this is accomplished by having two bevels at the ends, as at H K; the bottom G need not be supported. The ring C should be made of wrought iron, as it will have to withstand a heavy pressure. To guard against short circuiting the segments by the solder in connecting the wires with the ends E of the segments, the insulation B should be carried up to the top. See Figs. 49 and 51.

In winding the shunt coils it is necessary to make the connection with the inside end of the wire as strong as possible, because if it should break off, it would become necessary to unwind the wire. One of the best ways of accomplishing this is to use a flat sheet brass end piece, as shown at A, Fig. 53. This must be well insulated from the spool E, and also from the wire C, by means of the insulation B D. The wire is fastened to this piece A by being wound several times over it and then soldered thereto. This support will prevent it from moving endwise, especially as it is further held by the wire C pressing against it. Sidewise it is held by being let into a recess in the insulating ring D. Insulation at all points of electrical machines should be as firm and hard as possible; if not, it is liable to displacement in time. The wire should be wound in as compact as possible, but not crowded, and in handling it, it should be bent as little as possible. The work should be done in a room free from metallic particles, as if these get into any part of the wire they are almost sure to destroy the insulation in short order.

NOTES HERE AND THERE.

John Lookaback.

MAC'S EQUALIZER.

Mr. Editor: Some time since I wrote you that Mac and I had got a rather steady engagement going around among the old man's engines—the new and original—trying to persuade them into decent behavior.

When you get sent out, Mr. Editor, to inquire into the behavior of an old engine that has wrestled with adversity for twenty years, you expect to find everything at all sort of ends and you only get disappointed when you find something that don't require rejuvenating. Don't seem as if things were going just as they ought to go. But when you find an engine just out of the shop that can't be made to behave short of a couple of weeks' tinkering, it's another thing; makes you kind of lose your interest in engines, generally. Think that you might do yourself more credit managing a cinder mill, or something of the sort.

Some of Mac's plans for getting the old man's engines out of difficulty remind me of a little experience we had, Mac and I, with a shaft governor, in the days when shaft governors were not so common as now; that is, Mac had the experience and I helped him. Mac was working for Spraker, over in a Connecticut town that needn't be mentioned. I struck Spraker for a job and Mac and I worked together. Spraker had a rather nice little shop for making most anything from a saw mill crank to a mouse trap—just a machine shop. Making good money, Spraker was, till one day he got struck hard with the steam engine craze. Just the kind of a man to get turned around with that sort of a craze, Spraker was. Didn't know anything about a steam engine till one of his unlucky days he accidently read that ninety per cent. of the power was lost through its wastefulness. That was enough for him. Never stopped to inquire how you could waste what you never had—good many just like him. There was a hundred per cent. of usefulness in the coal, and all along with the unregenerate steam engine only ten per cent. went to turn the wheels around. Ninety per cent. dead waste was too prominent a margin for working up savings for Spraker to let slip. Chance for saving twenty or thirty per cent. most anywhere when the margin was ninety. No wonder Spraker got into plenty of trouble promising big savings to customers through adding this or that to an old machine that ought to go through the cupola, but this never seemed to trouble him much; never brought him around to believing that perhaps he didn't know much more about the steam engine than men who had meddled with the matter for a life-time. When he failed, just thought he had struck the wrong lead, Spraker did; hit it right next time, sure. That's what Spraker thought. Good deal like you, Mr. Editor, speculating on Wall street, Spraker's steam engineering was.

When I struck Spraker's, Mac was rather busily engaged in working out one of his thirty per cent. schemes. Had a contract on his hand, Spraker had, to put an automatic cut-off on the vertical mill engine over at Mile Run. This, as I have said, was in the earlier days of the shaft governor, and an itinerant inventor had sold Spraker one; guaranteed it to save about all the coal burned over anything else in the shape of a governor. The mill engine had been well built and was running well. It was fitted with the Meyer cut-off, the essential parts looking something like Fig. 1. The plan was to put in a new slide valve, with

a cut-off plate on the old cut-off stem, handled by the shaft governor.

Mac had been consulted in the matter just about as a good deal of such consulting is done. Wasn't supposed to suggest anything, Mac wasn't; just agree with Spraker so he could have some one to swear at if things didn't go right. Good deal of that kind of consulting done, you know. Mac knew what was expected of him, but he was a little more obstinate than usual.

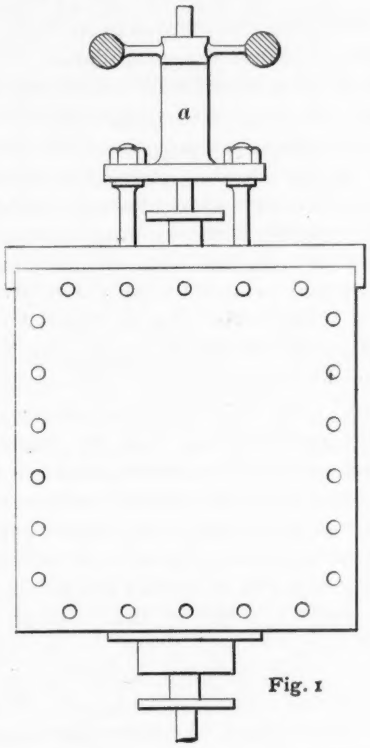


Fig. 1

"Look here," he remarked to the inventive genius, "that valve and the parts that are hitched to it, will weigh 300 pounds; that means 300 pounds dead weight against the governor half the time and with it the other half. Looks to me no governor is going to do much in the way of governing with 600 pounds against it. Make it rather shaky I should think."

The inventor flew right up. "Shows, said he, "that you don't know anything about what that governor will do; 600 pounds against it. Why that governor weighs 500 pounds if it weighs anything; 500 pounds in revolution; in revolution, sir; hold of that little, insignificant cut-off plate. Your early education in regard to centrifugal force has been sadly neglected. Just sat up nights with it, I have, and I can make figures show that that governor will attend to business better when it's got something to busy itself about than when it's loafing around."

Mac didn't argue the point and Spraker looked at him just as though he would like to say, if he only had time: "Better let these fellows alone who know all about such things."

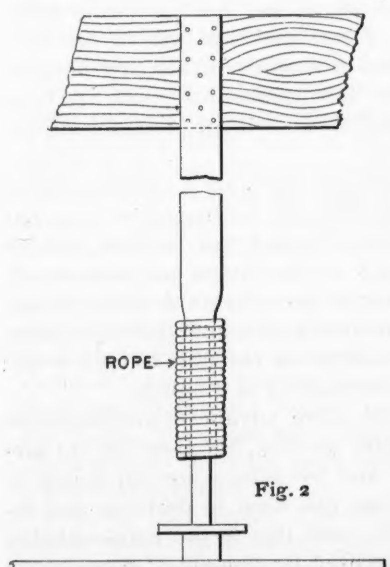


Fig. 2

The night before Spraker had promised that the engine should be ready to run at 7 o'clock in the morning. Mac and I made an all night of it. We got her ready to turn over about 4 o'clock, and Great Scott, how that valve handled the governor. Mac got her stopped while the pieces were all in place, then he sat down on an empty keg and thought about five minutes.

"John," said he, "you go over to the shop, wake up the night watchman if you can and get one of those rubber bands Spraker stocked up with when he was going to build about a thousand of those flax pullers he got stuck on, and a ball of marline. I'll pull things out of the way while you're gone. See what we can do about that jumping."

The band Mac sent me for was about three inches wide and a half inch thick, made of rubber that would stretch to twice its original length and recover itself again. One end of the band Mac lashed to the outside end of the valve stem and stretched to sustain the 300 pounds that worried the governor, the other end was spiked to a convenient overhead timber. The arrangement looked about like Fig. 2. We started up and that governor went along as smoothly as need be.

Of course this wouldn't do as a permanency, and Mac reported so to Spraker. Spraker scratched his head, looked a little bored, and then fell back on his usual resources.

"See here, Mac, I sent you over to put that governor on that engine and make it work right, and just when I'm all tangled over some hurried orders I expect next week—haven't got a minute to spare—you come around with a mournful story all about that governor jumping a little—just what any good governor will do till it gets broke in. Didn't expect it to take hold without some flattering, did you? If I had just about an hour's time I'd fix it so that no one but the fireman would know it was around. If I were you, Mac, I'd take that little jump out of it right away and not bother anybody with how I was going to do it, either.

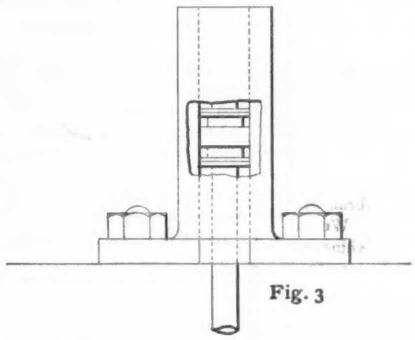


Fig. 3

Mac went away with an I-knew-how-it-would-be sort of an air, and in half an hour had the old pattern-maker at work on a pattern for everything in the world like the cross-tail *a*, Fig. 1, only a little larger in the body. When he got this through the sand he bored it out 2¼ inches (the pressure was 80 pounds) and fitted it with a piston. That piston, shown in Fig. 3, just about balanced the down-hanging weight on the governor, and may be doing so to-day, perhaps.

Mac had something in that little piston that might be useful in other places, but he waited about the patent part of the business. Finally an engineer on a government vessel, an acquaintance of his, wanted him to apply the balance piston to his engine. The engine was a link motion, and it took the whole available force to reverse her. Mac's piston was to be used to counterbalance the parts that must be moved in reversing. Mac was getting ready, rather leisurely, to make the application when, happening to take up an English journal, he found that an English engineer had patented substantially the same thing and for the same purpose, that is to balance the link to make reversing easier. Then Mac abandoned the whole matter.

[We can vouch for the accuracy of the last statement in Mr. Lookaback's narrative, as well as for most statements that precede it, with the exception of names, regarding which we are constrained to accuse him of a convenient forgetfulness rather common to him.—Ed.]

MACHINE TOOL ADJUSTMENTS.

We not only have graduations on the adjusting and feed screws of milling and grinding machines, but the idea—some would say the hobby—is being extended further, and in some cases is applied to lathes, planers, shapers, etc. Taper attachments are now made with micrometer adjustments, and the tendency is to make machines in general so that adjustments can be easily made by definite and known amounts.

A machine to which this principle could be applied to advantage is the vertical boring mill. Most mills, especially the larger sizes, have worm adjustments for the heads, which are convenient, and all sizes are provided with graduations in degrees. But when it comes to boring a hole straight or of certain taper, these graduations serve only to show in the roughest way where the head should be set, and a workman will generally have his own marks to go by. Even then the head cannot be set with any degree of accuracy until one or two cuts have been taken, so that the hole can be calipered. A good vernier attachment would help matters, although with as large a mass of matter to be moved as there is in an ordinary boring mill head, to say nothing of the liability of the cross rail being out of truth, a workman would not feel sure that his size was coming right until he had taken a trial cut. The vernier, moreover, would show how much the head was moved in resetting, and would thus make the work of setting much quicker.

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DECEMBER, 1897.

CONTENTS:

MANY subscribers to MACHINERY who have met Mr. A. L. Graffam during his eighteen months' work on the paper will be glad to see his name on the editorial page of this issue as an associate editor.

* * *

WE present in this number a mass of matter in the way of notes from Cincinnati shops that cannot fail to be of great interest to every mechanic. The average mechanic is so tied down to his work that he seldom gets out among different shops to see what others are doing; and when he does take a vacation he wants to spend it somewhere else than in a machine shop. Moreover, even if he were to go for the purpose of gathering information, he would see about the same things that he had been accustomed to. He would find difficulty in singling out the features of a shop's practice that differed from the ordinary run of work, especially if those in authority were reticent about disclosing them. The shop notes contained in this issue, therefore, are illustrations of the benefit that may be derived by reading mechanical papers devoted to such interests, and at a cost which is almost insignificant. They help make broader and better all-around men, besides contributing directly to one's store of knowledge.

THE WAY OF THE BICYCLE.

When the bicycle was in its infancy, before the diamond frame became the established thing, every inventor felt called upon to originate something different, and "freaks" were the order of the day. Now that the frame question is settled, about the only thing left for the exercise of ingenuity is the driving gear, and apparently we are to be treated to a series of freaks in driving gears.

Of course there is nothing freaky about a good gear drive; it is in line with ordinary mechanical practice, and usage may establish that it will give either a little better or a little worse results than the chain. This cannot be told at present, but it makes a mechanic smile to read of the adoption of gearing as a "marvelous and wonderful achievement." As an old bicyclist has expressed it, who has been at it long enough so that he ought to know, "Noah used bevel gears with which to steer the ark," so there is nothing very marvelous about the present use of gearing.

In the early days of the steam engine it was "anything to beat the crank;" now it is anything to beat the chain, and to this end inventors are springing up without number. We suspect, however, that instead of "anything to beat the chain," it will prove to be "anything to beat bevel gears," and the case seems to be very similar indeed to that of the early steam engine. When James Watt wanted to use the crank, he found that it had been patented by another inventor, and it was obvious to him that if he were to be "in it," he must devise something else—something better, of course. If, as we understand, the patents on bevel gears as applied to bicycles are controlled by one firm, other manufacturers will be under about the same conditions as James Watt, and everything points to an interesting season for bicycle mechanics.

MATHEMATICS.

The subject of mathematics is one upon which we believe there are a great many one-sided opinions. There are those who go so far as to say that no mathematics beyond arithmetic are of any practical use in machine design or construction, and in support of this view point to the fact that much of the best mechanical work has been done by men who have had no knowledge of higher mathematics.

Passing to the other extreme, there are a number of men who have become so filled with the mathematical idea that they can believe that little of value can be done without elaborate calculations, such as they alone can understand. It so happens that these men are often the ones who are the best qualified to write text-books, and therefore many of our best text-books are about as readable as they would be if the text were in Greek instead of English.

As a matter of fact the more advanced mathematical subjects serve a very useful purpose, but they are not useful for every-day work, and by nature are not suited to such work. Their real use has been in deriving and developing formulas, which—and this is the point—having once been obtained can be used by the aid of some of the simple principles of algebra and trigonometry, and if put into proper form, by the use of arithmetic alone. For example, the formulas for the friction of belting, the work done in compressing air, and the strength of a shaft subjected to combined bending and twisting, are all originated by higher mathematics; but to use these formulas, none of the higher mathematics are required.

No one can justly complain, therefore, because a text

book contains a mathematical treatment. The derivation of the formulas ought to be given so that anyone can judge of their merit, especially if the book is for students' use. On the other hand, there is no reason why the matter should not then be put into such shape that, when the formulas have once been derived, they can be understood and used by the average person who has occasion to refer to them.

BOOKS FOR STUDY AND REFERENCE IN STEAM ENGINEERING.—I.

We are occasionally asked to recommend some book or books upon steam engineering, or some branch of this subject. The question is one that probably interests others besides those who make the request, and a few books will therefore be named which can be used advantageously for reference or study, together with a few hints concerning them and their use.

Probably no mechanical subject has been so popular with authors as that of the steam engine. There are books by the hundreds, of all kinds and descriptions, from which many satisfactory lists could be prepared, and, it may be well to add, many more that would not be satisfactory at all. In making up a list one is naturally influenced by what he has been accustomed to, and is inclined to favor those books with which he is familiar. It does not follow, therefore, that the books here enumerated are necessarily the best ones of their kind; another person might select a totally different list which he believed to be as good or even better. It is believed, however, that the books recommended are all good ones, and will rank among the best.

In this issue we will turn our attention to books for stationary engineers, and in a later number a list will be published for those who wish to study the theory, design and construction of steam machinery.

BOOKS FOR STATIONARY ENGINEERS.

Before naming any books for engineers, a few suggestions will be offered for the benefit of those beginners in the subject of steam engineering who feel that they are deficient in the mathematical side of the study; and as these remarks are intended to apply only to readers who come under this heading, others can skip them.

It may seem strange and rather discouraging to an engineer to have a common school arithmetic recommended as the best book to begin with; but if there are any who want to undertake a course of study in any mechanical subject and feel a little uncertain about their arithmetic, it is by all means the book to take up first. The slowest and most unsatisfactory way to advance in any subject is to begin at the middle and try to work both ways, and the best and most rapid way is to start with first principles and go ahead progressively, step by step. Very little genuine advancement can be made by attempting to study arithmetic and steam engineering at the same time.

There is not much choice in arithmetics. A good way is to select the one used in the local schools, as some friend who has studied the same book may then be able to give assistance if needed. The choice is not so much in the arithmetics themselves as in the sections which should be studied. If one is deficient in arithmetic it is a good deal of a task to wade through a complete text-book on the subject, and it is not necessary. Any engineer, however, should be able to work out examples under the following headings: Cancellation; Least Common Multiple; Common Fractions; Decimal Fractions; Denominate Numbers; Ratio and Proportion; Square Root; Mensuration of Surfaces and Solids; The Elements of Percentage (first principles only). These sections cover the parts of arithmetic that will be most useful to an engineer.

Next, as to the books. The list for stationary engineers includes but four, as follows:

On steam and the steam engine, "Elementary Manual on Steam and the Steam Engine," by Jamieson. Published by Charles Griffin & Co., London, and can be obtained from D. Van Nostrand Co., New York. Price, $1.40.

On the indicator, "Indicator Practice and Steam Engine Economy," by Hemenway. Published by John Wiley & Sons, New York. Price, $2.00.

On boilers, "Wilson's Boilers," by Flather. Published by Wiley & Sons. Price, $2.50.

On care and management of the steam plant, "The Power Catechism," by Low. Published by The Power Publishing Co., World Building, New York. Price, $2.00.

Although this list is very brief, an engineer can obtain in the books named, all the information necessary to pass any examination for an engineer's licence.

The first book mentioned is an English work, and some of the matter which it contains will be found to differ from American practice. The general principles are very clearly explained, however, and there are numerous examples to be worked out by the student, which add greatly to its value.

The second book is a standard work and is too well known to need comment.

The third book, like the first, is of English origin, and moreover, was written a quarter of a century ago. It therefore presents English practice largely, and is not as modern as might be wished. These faults are largely offset, however, by two chapters which have been added by Prof. J. J. Flather, upon modern American practice and methods. It is difficult to name a book upon boilers exactly suited to the needs of engineers, but this one probably as nearly fills the bill as any.

The last book mentioned has just been published, and is noticed elsewhere in these columns. It contains a large number of practical questions for engineers, with their answers. Besides giving information on the care and management of the plant, it may help out when the student finds that he cannot understand the mathematical part of any one of the other books, especially of Wilson's boilers.

L. G. F.

GRINDING VALVES.

F. F. Hemenway.

In grinding bronze valves and seats, too much attention is usually given to getting a joint that is just tight and too little to getting one that is not only tight but durable, that is, one that will remain tight and not wear out quickly. For the purpose of grinding such valves perhaps nothing is better than pulverized quartz, which can be had of most dealers in engineers' and machinists' supplies. Emery should never be used; it lacks personality, so to put it. There is too much intention for the individual particles to congregate in wind-rows, as the haymaker might call it; the engineer or machinist would say it streaks the surfaces.

To obtain good durable bearing surfaces, grind with the quartz, using the coarser first and finishing with the fine, if the surfaces are old and somewhat cut. If the surfaces are newly made ones, the coarser should not be required. In any case do no more grinding with the quartz than is absolutely necessary to bring the surfaces fairly together. The most that can be said of grinding surfaces into contact is that it is one of the most inaccurate processes known to the mechanic, which is saying something that need not be argued. Bring the surfaces just fairly together, then carefully clean off, put on plenty of oil and *wear* them together just as if grinding. This requires some patience and considerable labor, but the result obtained, whether the surfaces be large or small, or the dealing is with a half-inch or a twenty-inch valve, is ample compensation.

The surfaces, left just as the grinding material leaves them, may be steam-tight, but they will not stay tight for so long a time as if *worn* tight in oil. The reason is obvious. In the first instance the surfaces are soft and full of minute holes that would be revealed under the microscope, in fact they are plainly seen by the naked eye. In the second, these holes or depressions are far less numerous and the bearing surfaces are hardened, burnished surfaces.

It is a fact well known by metal workers that a piece of bronze —or cast iron as to that matter—will, if lightly hammered all over before the final finishing cut, finish very fine and even. The slight hammering fills up the pores and solidifies the surface. This seems, in the instance of the valve and its seat, to be accomplished by what may be called the oil-grinding. It is, probably, needless to say that during this process an abundance of oil should be kept on the surfaces. Without this precaution the surfaces will be cut or scored.

* * *

New projects for developing more of the power of Niagara Falls are continually cropping out on both the Canadian and New York sides. Looks as though Niagara's vacation days are about over.

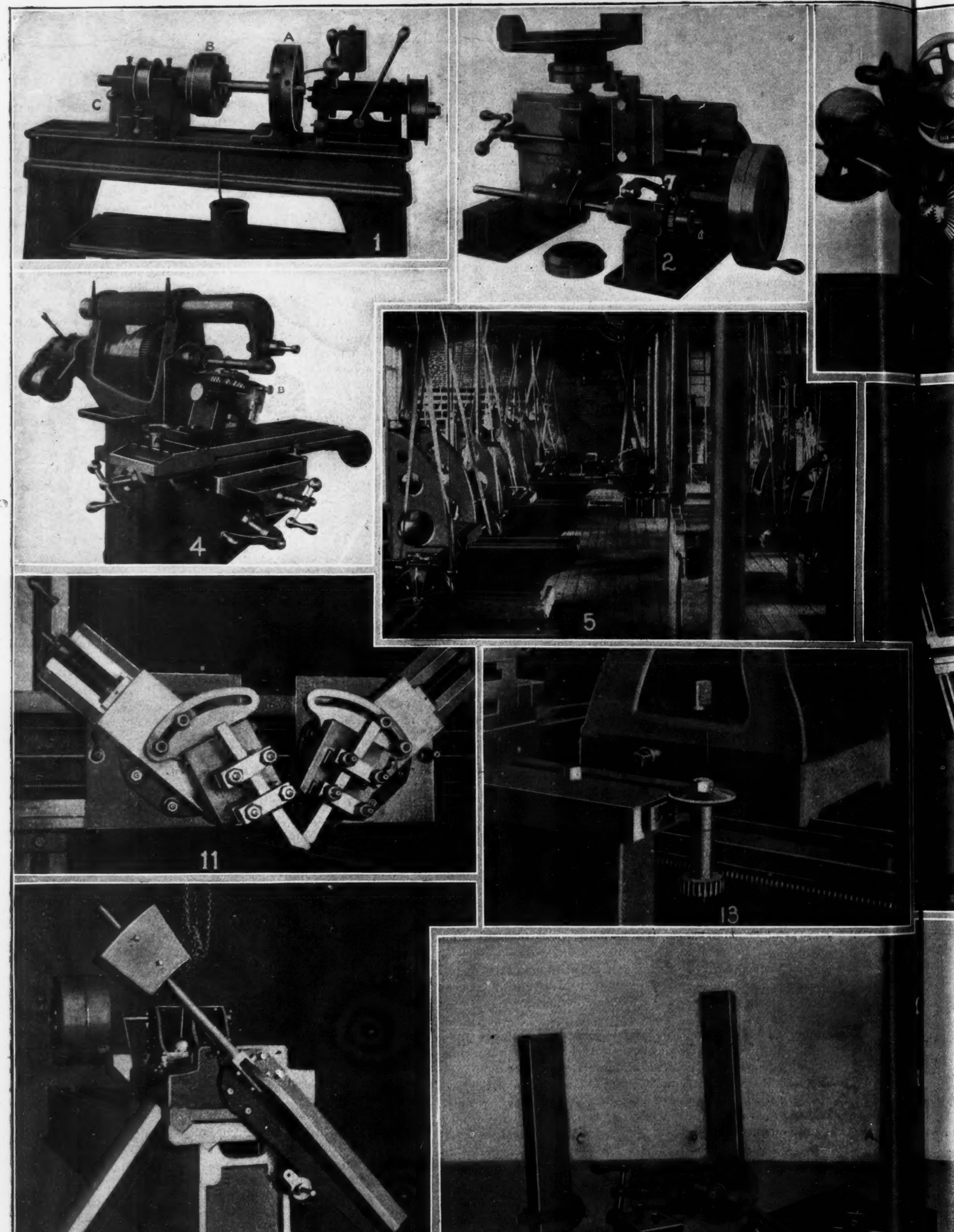
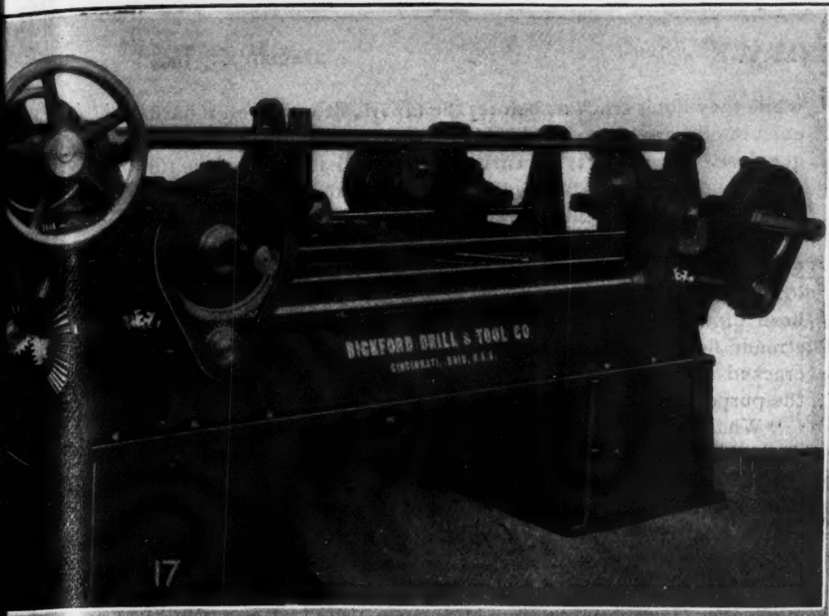
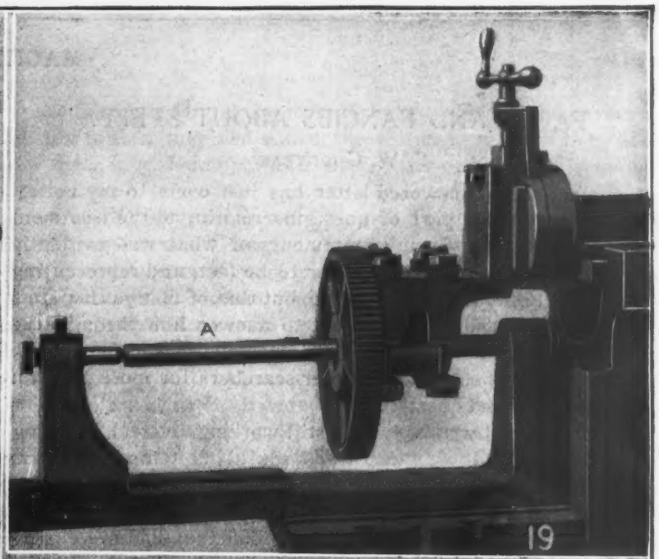
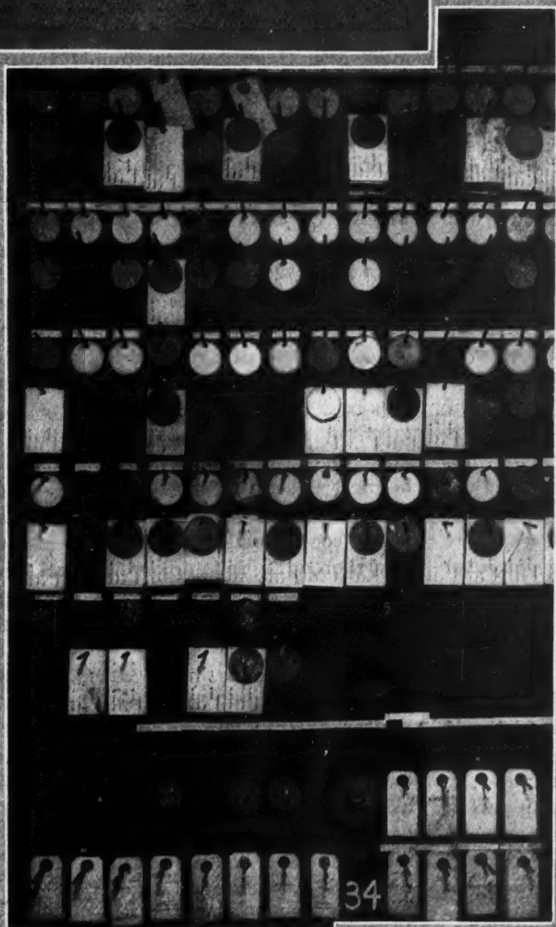


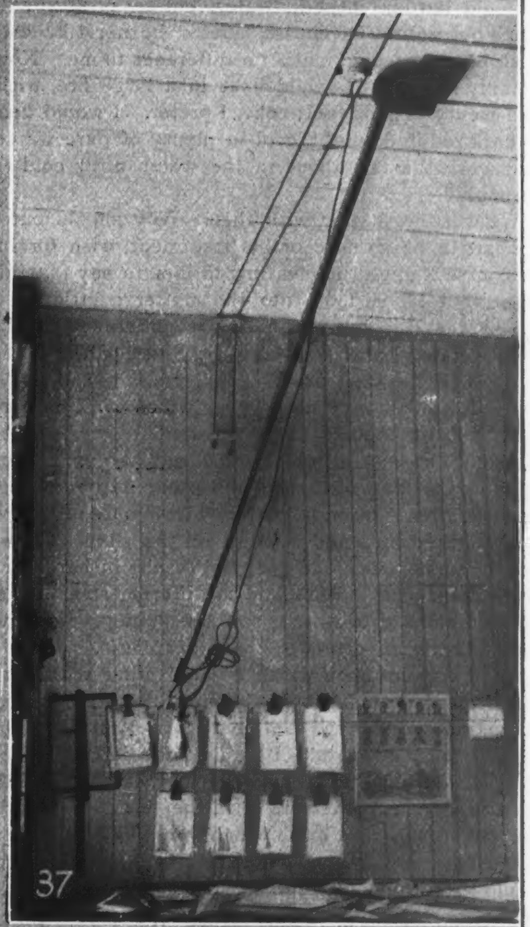
Fig. 1—Centering and Countersinking Machine.
Fig. 2—Universal Graduating Engine.
Fig. 4—Bevel Gear Jig.
Fig. 5—An Up-to-date Planer Department.
Fig. 11—Method of Planing Vees.
Fig. 13—Thread Indicator.
Fig. 14—Bed Facing Attachment.
Fig. 15—Bench of Planer Tools.

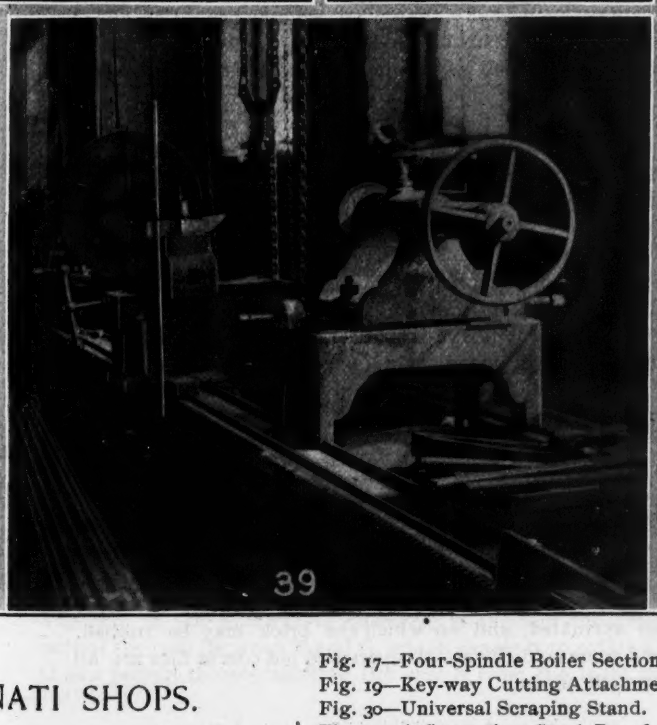
VIEWS FROM CINCIN

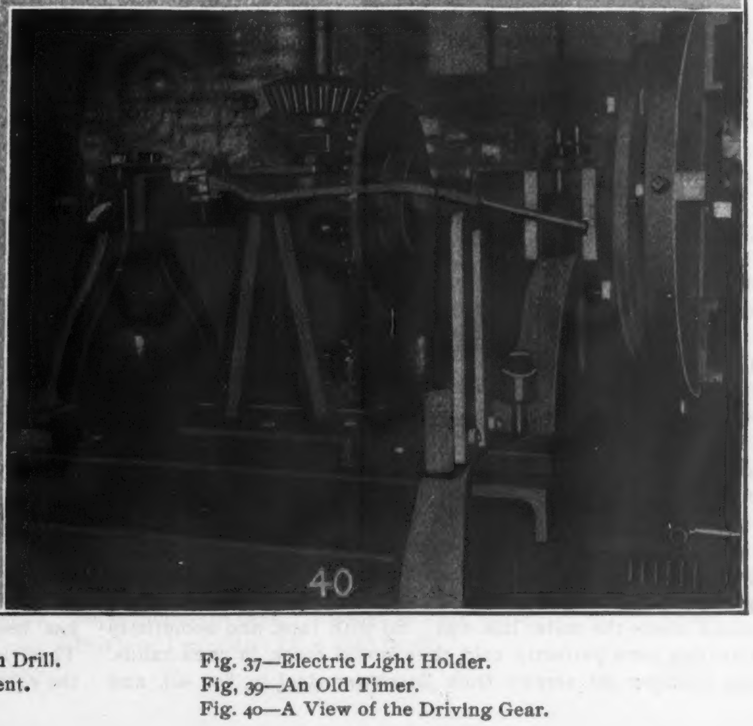












M CI CINNATI SHOPS.

Fig. 17—Four-Spindle Boiler Section Drill.
Fig. 19—Key-way Cutting Attachment.
Fig. 30—Universal Scraping Stand.
Fig. 34—A Convenient Stock Board.

Fig. 37—Electric Light Holder.
Fig, 39—An Old Timer.
Fig. 40—A View of the Driving Gear.

FACTS AND FANCIES ABOUT STEEL.

S. W. Goodyear.

A mislaid and unanswered letter has just come to my notice, which is made up in part of questions relating to the treatment of steel. It contains many statements of what was evidently believed by the writer of said letter to be fact, and representing as it does not only his own practice, but that of many other steel workers, it has occurred to me that to answer him through the columns of a paper so widely read by steel users as your own, will possibly be of some use to other searchers for more light on this much discussed question.

First, our friend writes, "I am still working in steel, dressing tools, and a friend of mine asked me about tempering some heavy taps, or rather hobs, pipe thread, 4 inches diameter. Some had been tempered and cracked; reason given, they had no oil to harden them in. I said that when they had more to do I would harden them in water, but he is afraid they will not come out right. Of course neither he nor I knows whose steel it is, but that would make no difference to me. Now I will give you my method. I would heat in a large fire, with slow blast and plenty of good fuel; coke, I prefer. I would heat uniformly to dark red in daylight, cool in plenty of pure water, about 70°, and work the tap about in the water until cold through and through."

What is the matter with this? Why should our friend, who appears to be so sure of his treatment, wish for information? Of course it might be pleasing to him to say that his method is right, but let us look into the matter a little. "Don't know whose steel it is, but that makes no difference." Why, my dear Tool Dresser, here is just the very pith of the whole matter, to know what the steel is! You say, "dark red in daylight." That depends. You may have steel which *will* harden at "*dark red*," but the chances are a hundred to one it will not, in size stated. The heat at which steel will harden properly depends upon its per cent. of carbon and other hardening elements, the heat required ranging all the way from dark red, through all the shades of red, into and through all the shades of orange, up to bright lemon color. To get good results in hardening you *must* know *what* your steel is, and as different steel makers differ in their opinions as to what is suitable temper for general use, it becomes highly important to know *whose* it is.

Another point upon which I would differ with our friend, the tool dresser, is this: He would churn the tap, or hob, of 4 inches diameter, around in the cold bath "until thoroughly cold through and through." I would take it out while there was still considerable heat remaining in the interior of the piece; in fact, as soon as I was sure that the teeth, the working part of the tool, had become hard, which would be *before they were cold*, and before they had reached the brittle, breaking condition. I would then immediately proceed to equalize the heat throughout the entire mass, thus removing antagonistic strains, and as the whole cooled down together, the danger point would be passed with no cracks or checks which so often come in the teeth of taps, reamers, milling cutters and similar tools.

How do it? Well the most primitive and simple method perhaps, is to put the piece over the hot embers or inside a pipe heated up for the purpose. This requires much care, however, as the edges of the teeth may have the temper started too much. A safer and more reliable plan is to put the tools into heated water or oil, or into a bath of heated sand. Any good way to equalize the heat and strain will answer, provided there is still sufficient heat in the piece to make the parts liable to break tough enough to place them out of danger. This relief from strain not only prevents hardening cracks which so often occur in the process of hardening, but prevents breakage later on, hours, days, or even weeks after the hardening has been done, as who has not known of such cases?

Here is another question which our tool dresser puts, and then goes on at length to give his own opinions. "What do you think of Bessemer steel for fine tools, taps and dies, and lathe tools?" "My trouble with it has been as follows: In tempering a set screw you know the end wants to be hard so as not to bur up and spread, while the body can be left soft. I would heat only the end, harden in water, and it would split and crack almost all around where the water line was. So with taps, and sometimes after they were perfectly cold they would crack in ones hands. Now I temper set screws from Bessemer steel in fish oil, and while they don't crack as before, the taps don't wear well if hardened in oil—are too soft. This steel won't refine nicely; it don't get close. They call it .70 carbon, and I call it N. G. It is full of hard spots, and sometimes after it is annealed there are spots that a tool will just glide over as if greased. For hot work it does pretty fair, but as soon as you heat it and put it in water, it goes to pieces. A die 10 x 10 x 4 inches I heated in a furnace to a low heat, slowly and uniformly, and when ready plunged in a bosh of water 5 feet by 2 feet by 18 inches, and a ¾ inch pipe stream flowing in at the same time. When nearly cold, it cracked in four pieces, but I put a band around it, so it answered the purpose. Can you help me to the point?"

"What do I think of Bessemer steel for fine tools?" Why I don't think of it for such purposes at all, my friend. A good crucible cast tool steel is not too good, and for many uses the best to be had is the cheapest, no matter what the price is. Bessemer steel of .70 carbon for taps and lathe tools! Why, if a good crucible lathe tool steel at 15 cents per pound, or even twenty cents, should be put in use against such tools as could be made from the above mentioned steel, even if it cost only two cents per pound, and an account kept of one day's use, it is my opinion that the question of value at night would stand about thus: Excess of work turned out during the day with tools from a good, high carbon, crucible cast, lathe steel, would cut down the investment, as compared with production from the use of Bessemer, .70 carbon tools, to nothing. Difference in one day's use would pay the entire first cost of the steel, while if the loss from using the two cent steel were to be added to first cost, it would be found to have cost one dollar per pound. A strong statement? Look into the matter a little and see if it is not a fair way to put it. What about a tool needing to be taken out and ground once in two or three inches against a better tool standing to turn on same piece as many feet? What about grinding and resetting once an hour against the tool which keeps on cutting without regrinding for an entire day of ten hours? Cases there may be of Bessemer steel of sufficiently high carbon making good tools, and if the tool is good it should not be condemned on account of a name; but when it is the fact that thoroughly reliable crucible tool steels can be had, on which the brand and temper marks stand as guarantees of quality and uniformity, I see no reason why they should not be used for fine tools.

"Cost too much, can't afford to use them," does somebody say? Now really, my friend, I think if you will look into the matter carefully you will find you can't afford to use the cheap stuff. It is often a question of a dollar's worth of steel with from ten to one hundred dollar's worth of labor put upon it, and aside from the question of breakage and entire loss, the question of ultimate value will creep in. Said a bright manager of a manufacturing establishment in which much steel is used for dies, "Show me a steel which will give us barely ten or fifteen per cent. added service in our dies and we will adopt it, even if it costs fifty per cent. more than what we now use. Can afford to in increased production of goods, owing to less loss of time in changing dies, as well as in increased returns for time spent in making the dies, for just so much work must go into them anyhow, no matter whether they last one day or a week."

But perhaps my tool dresser friend will think I have forgotten him. About that die 10 x 10 x 4 inches, which "went into four pieces when nearly cold." It should have been taken out of the bosh with running steam before it got so nearly cold, before it reached the danger line in cooling, and the heat and consequent strain should have been equalized through the entire piece. Taps and milling cutters the same way. "Set screws breaking at the water line;" don't have any water line—either plunge them in as far as heated, or move them up and down. Don't get in the way of laying all the blame to the steel, even if it is Bessemer.

* * *

It pays to expend a little care in finishing and filling the castings of a machine. Expensive labor is not required, and a day's work properly directed will make a good sized frame look ten dollars' worth better. Have a supply of coarse-grained emery brick, and, to take the glaze off, have a cast-iron plate, planed on one side, set near at hand, on which a handful of emery has been sprinkled, and on which the brick may be rubbed. These and some cold chisels, scrapers and old coarse files are all the equipment needed.

THE DRAFTING OF CAMS—3.

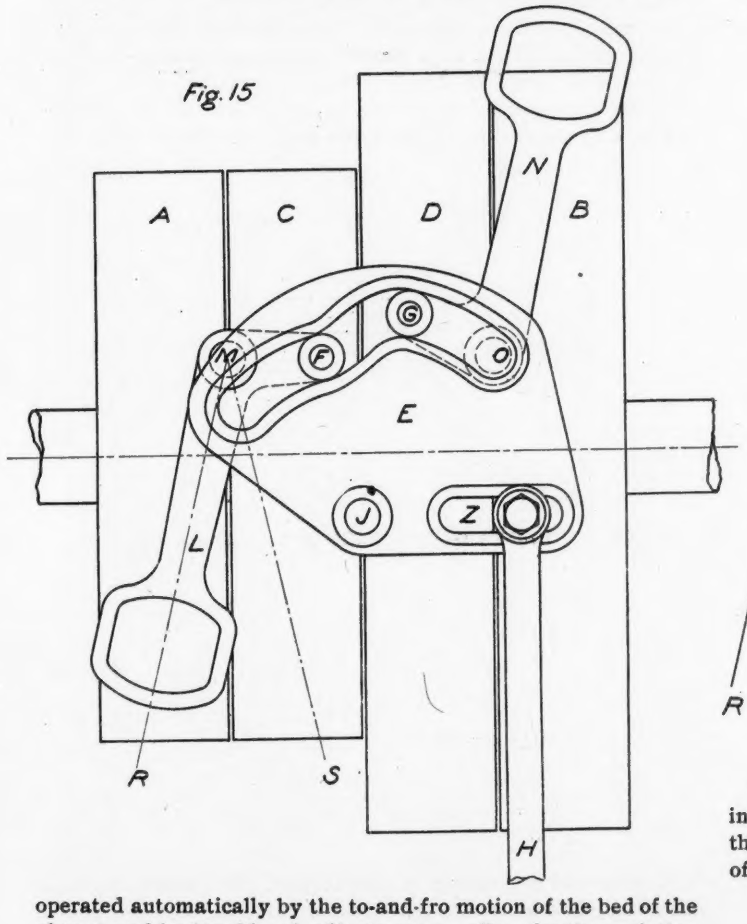
[LOUIS ROUILLION.]

The following problem in machine design is one of a series given to the students in mechanical engineering at Cornell University. It furnishes a good example of the method of reasoning applied to practical problems in mechanics, and is also an interesting problem in quick-return motions.

The problem calls for the designing of a device for automatically shifting the belts of a planer. The driving shaft has a fixed pulley of wide face carrying two belts. The driven shaft has two sets of a loose and a fixed pulley. One set, smaller than the other, is driven by a crossed belt, and its shaft therefore rotates in a direction opposite to that of the driving shaft. The larger fixed pulley drives the planer while the tool is cutting, and the smaller fixed pulley causes a quick return of the tool while no work is being performed.

The shifter should be placed near the driven pulleys so as to operate each of the belts at its point of approach to its pulley, and to operate each belt separately. The shifter must also be operated automatically by the to-and-fro motion of the bed of the planer, and be capable of adjustment to allow for the variation of the momentum of the machine under different loads.

Fig. 15



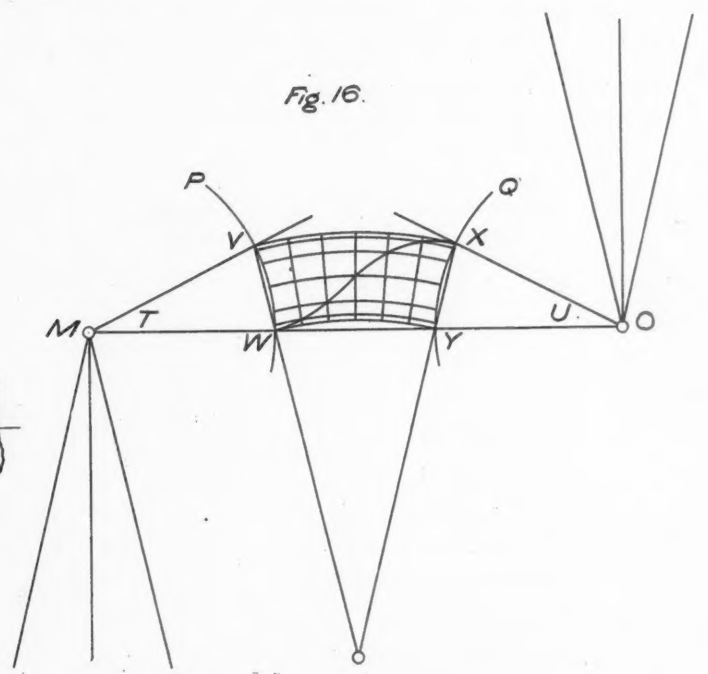
In Fig. 15, A and B are the two loose pulleys of the driven shaft and C and D the fixed pulleys. E is a covered cam rotating about J and having two roller followers F and G. H is a link driven to and fro by a tripping device attached to the planer bed. L, the shifter-arm for the smaller pulleys, is a crank rotated by the follower F about M as a center. In a similar way the crank N rotates about O. The pivots J, M and O are carried on a plate made fast to the planer and not shown in the drawing. The portions of the cam to the left of F and to the right of G are arcs of circles with J as a center, and therefore while either of the followers is traveling through these arcs there will be no movement of the shifter-arms. The throw of either of the arms is occasioned by its follower traversing the irregular path between F and G.

Imagine the link H drawn towards the lower part of the page. The cam then rotates towards the right about the center J. The follower F is held fixed in its position by the arc of the cam to its left, and therefore the shifter-arm L remains stationary. The path of the follower G, however, is through the irregular part of the cam between F and G, which causes it to rotate about O as a center, thereby shifting the arm N from the loose pulley B to the fixed one D. If the link H is operated in the reverse direction to that imagined above, the shifter-arm L will then become the active member, and the shifter-arm N will remain inoperative.

A method for determining the irregular path of the centers of the followers F and G is shown in Fig. 16. First locate the points M and O from Fig. 15, and draw the circular arcs P and Q, the paths of the centers of the followers F and G. Then draw R and S, the extreme positions of the center line of the shifter-arm L. Make angles T and U equal to the angle formed by the lines R and S. Lines drawn through V W and through X Y will intersect at J. Divide V W into six parts proportional to 1, 3, 5, 5, 3, 1, and through the points of division draw arcs with J as a center. Divide V X into six equal parts, through which draw radial lines. The successive intersections of the circular arcs and the radial lines determine the path of the centers of the followers F and G, as W X.

Lines drawn tangent to successive positions of a follower along the line of centers W X will be the outline of the cam-slot at its irregular part.

Fig. 16.



The slot Z permits of the adjustment of the link as called for in the conditions of the problem. The center of the opening for the belt in the shifter-arm L is placed nearer to the center line of the shaft to allow for the angularity of the cross belt.

PLACE NOT STATED.

MR. EDITOR: We all make mistakes once in a while, or oftener. In a large and well-known city where they are supposed to know a thing or two, the general manager of the Street Railway & Lighting Company probably knew more about time tables, etc., than he did photography or engineering, for one day he sent a photographer up to the power station to take a nice large photograph of its interior. He got his camera set about right and required the engines to be stopped. He was there with orders from the manager to take the picture, so the superintendent said all right. The engines had been stopped about five minutes and the final adjustments of the camera was about completed when the superintendent happened to think that the whole street car system was paralyzed and it was high noon when everyone was in a hurry, so he made a run for the engine to start it while the photographer howled because he would spoil the picture. The exposure was made while the first engine was being started and the superintendent's picture appeared in three places in the picture.

Of course it was the "other fellow" who was to blame, but the superintendent says, "I ought to have known better, but I didn't think or I wouldn't have shut down."

MILO.

MARINE ENGINE DESIGNS.—4.

VALVES AND VALVE-GEARS.

William Burlingham.

There are innumerable types and descriptions of valve-gear used in marine engine work, but in this country the two commonly used are the Stephenson link motion and the Marshall gear with its various modifications.

The Joy, the Bremme and others, have their adherents, but the majority of engineers incline toward the first mentioned types, and with reason, for they give a very good steam distribution and there is little wear on the pins, the gear in consequence requiring less care and attention and enduring for a much longer period of time. Of the Stephenson and Marshall gears, the former is by far the simplest and the one most commonly used. I should judge that at least eighty per cent. of the engines built to-day have the old Stephenson link motion. This type of valve gear necessarily increases the length of the engine fore and aft, and where this dimension is an important factor, the use of the Marshall or See-Marshall gear is advised.

The latter gear allows the placing of the cylinders side by side with the valve-chests athwartships in the case of a vertical engine, and on top of cylinders if a horizontal engine is used.

The Joy valve gear avoids the use of eccentrics altogether, and the motion obtained is undoubtedly preferable to that given by any of the other gears, for the reason that the two quick and the two slow periods of movements occur at precisely the right time, the amount of opening is equal at both ends of the valve and early cut-offs are possible without excessive leads or too early exhausts. Its disadvantages are that the moving parts interfere with overhauling the engine and examination while running, and again, a slack joint throws the whole gear disproportionately out. This valve gear will undoubtedly have a much more extended use in the future than it has had in the past, as it embodies many good points and its objections are not insuperable.

A perfect valve motion, not at present obtainable, would be one which opens wide to steam the moment the crank passes the dead center, and remains open during the admission of steam, thus avoiding wire-drawing and kindred evils; closes suddenly and remains so during expansion, at the end of the stroke it opens wide to exhaust and remains so until the time to open for the admission of steam. The amount by which the valve is open at the beginning of the stroke is called the lead, the amount by which the outer edges of the valve overlap the ports when in mean position is called the lap; when the inside edges overlap, it is inside lap; if the inside edges should be slightly inside the ports, the space would be negative inside lap.

With the ordinary valve gear fifty per cent. is about the earliest cut-off possible, and as tugboats and like craft often demand an earlier cut-off, it is necessary to use an expansion valve, or in other words, a valve sliding on the top of the main valve; this auxiliary valve is usually worked from a separate crank or eccentric, with a separate link and a traveling block to alter the travel of the valve and consequently the cut-off. This arrangement complicates the gear, but for the purpose intended it is probably the best method. The accompanying illustration, A, shows the ordinary type of double ported slide valve; triple ported slide valves are seldom used in this country and only for very large engines.

Since the introduction of triple and quadruple engines, piston valves have been extensively used and are the best valves for the high pressure and mean pressure engines. Their chief objection is their inability to leave the seat when grit or dirt is present and consequent strain imposed upon the valve gear.

There are various methods of fitting up these valves, but those of 6-inch diameter and less are preferably plug valves; that is, without piston rings. Some engineers advocate making the larger valves in the same manner, or with a solid ring, as with split rings the steam gets behind the rings causing excessive pressure and consequent wear on the liner. Still the prevailing opinion is that split rings are preferable.

As steam is usually admitted on the inside of the valve, that is, between the two ends, it is better to design the valve with a distance piece, thus allowing a variation of lead without the necessity of making a new casting. Large diameter valves have ring packing similar to regular piston packing. Cut B shows the U. S. Government practice in this respect. The materials of a valve like this are as follows: Piston followers, cast iron; packing rings, hard cast iron; distance pieces, cast steel; bolts and nuts, steel; nuts, wrought iron. Steady pins should be inserted where necessary, and provision made where required for lifting the parts. If the upper part of the valve has a pocket, it should be drained to the chest that the chest drains may take care of the water.

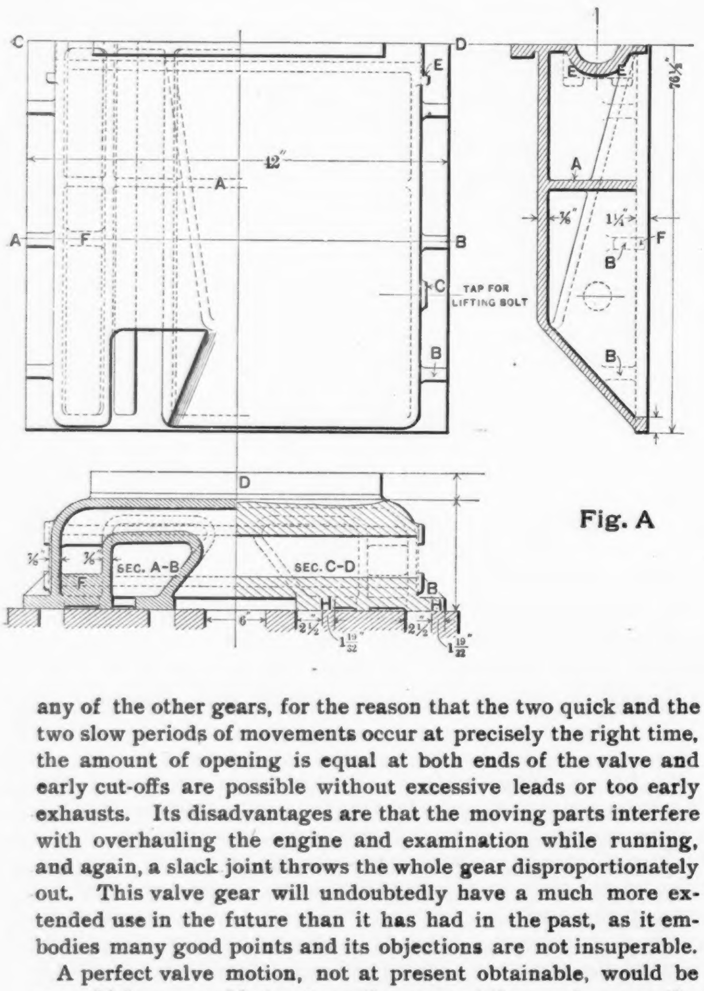


Fig. A

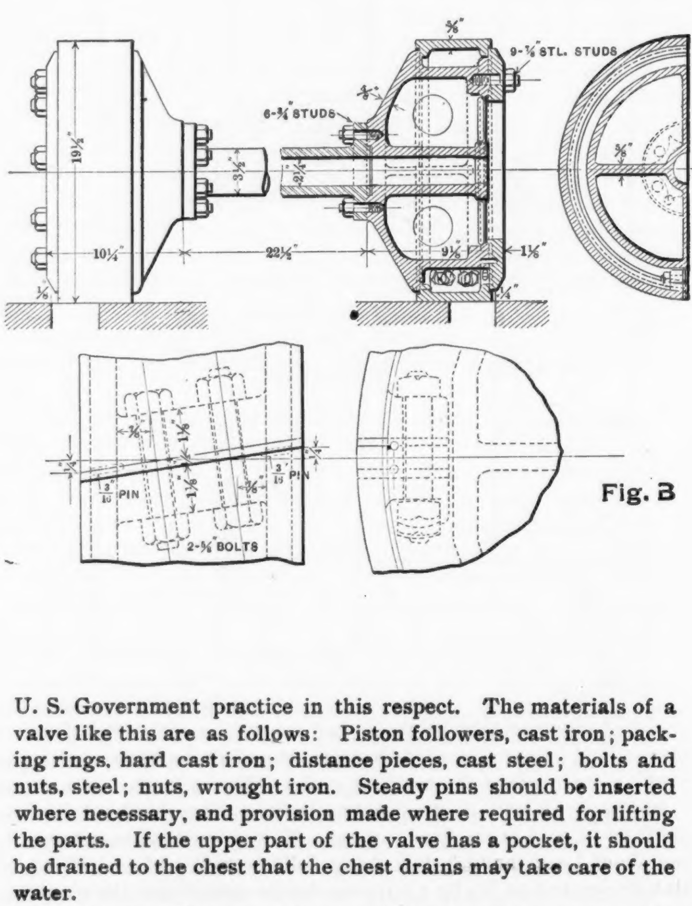


Fig. B

The follower rings must be very stiff and amply secured. The valve proper is usually kept from turning by being keyed to the valve stem in such a position that the ring joint is opposite the wide bridge in the liner. There are innumerable variations from the design shown, yet in all of them there are the same underlying principles—lightness, stiffness and strength.

The lead of a valve is usually assumed arbitrarily, taking the moving parts into consideration and the extent to which the engine will have to run when linked up. Experience is the best guide in determining the correct leads and the following is probably equal to the best practice, viz., small engines, such as auxiliary engines, have from $\frac{1}{32}$ to $\frac{1}{16}$ inch lead.

Tugboat engines and small steamers, from 600 to 1,500 HP., have from ¼ to ⅜ inch.

The ordinary coast steamer of 1,500 to 2,500 HP. from ½ to ⅝ inch.

Large steamers of 4,000 to 8,000 HP., from ⅝ on the high

pressure cylinder to ⅞ inch on low pressure, and ocean steamers of 10 to 20,000 HP. from 1 to 1¼ inches. The above are for piston speeds of about 900 feet per minute, and the usual type of engine.

Little or no inside lap is used, as with these leads and a well-proportioned travel, the exhaust begins in the high pressure at about $\frac{85}{100}$ to $\frac{9}{10}$ of the stroke. Valve diagrams are so well known and thoroughly explained in various publications that I will pass them, recommending the use of the Zeuner or the Bilgram as the two best.

Balance pistons are used for relieving the valve gear of a part or the whole of the strain due to the weight of the valve and gear. The area of the piston multiplied by the pressure per square inch in the steam chest to which it is connected should furnish a supporting power sufficient to counterbalance from ¾ to the entire weight of the valve and gear. These pistons are used only on large engines and are fitted up the same as an ordinary piston; the smaller with plug packing and the larger one with spring rings. The chamber above the balance piston on the high pressure and mean pressure should be connected through a trap to the feed tank, although in merchant work the trap is often omitted, and the low pressure is directly connected with the steam side of the condenser.

In compound engines the single ported or plain slide valve is used for the high pressure and the double ported for the low pressure. In triples, a piston valve is better for the high pressure, and double ported slides for the mean and low.

Quadruples usually have piston valves on the two smaller cylinders and double ported valves on the two larger. In nearly all government designs piston valves are used on all the cylinders. They are usually of the same diameter, thus making them interchangeable, the requisite port area being obtained by increasing the number of valves on each cylinder.

The travel of a slide valve should be as short as possible, from 2½ to 3 times the length of the steam port; flat-sided valves should have ample bearing surface, for if the pressure per square inch is high, there will be excessive cutting and rapid wear with constant leakage. If the ports are over 18 inches wide a central bar should be inserted, and wide faces should have two or more bars or ribs subdividing the port into spaces from 12 to 15 inches. Ample grooves are necessary, allowing the free use of steam as a lubricator.

It is very important that the steam and exhaust passages be large and smoothly cored, from 5 to 10 per cent. greater than the area through the cylinder ports—5 per cent. for the smaller and 10 per cent. for the large slow-moving valves.

In the larger engines it is not necessary to use springs to force the valve to its face after having been displaced by water; allow a slight clearance between the finished guide strip on the back of the valve and the inside of the chest bonnet.

As it is very advantageous to have the valve as light as possible, yet with a good margin of strength. It is necessary to figure the flat surfaces and not guess at the thickness. The following formula by Mr. Marichal, is one of the best and is, I think, as yet, unpublished:

PRESSURE ON PLATES ENCASTRE.

T—tensile strain on material in lbs. per sq. in.
t—thickness of plate in inches.
A—area of surface of plate in sq. in.
a—area of any triangular section of surface of plate in sq. in.
P—pressure on plate in lbs. per sq. in.
S—length of section in inches supporting strain.
L—load on any section "a".
c—distance in inches from base of any triangle "a" to its center of gravity.
M—bending moment of any section "a."
XM—sum of all bending moments acting on plate.

$$M = Lc$$

$$t = \sqrt{\frac{3XM}{TS}}$$

$$T = \frac{3XM}{St^2}$$

Example: P = 50 lbs. S = 132″ A = 1 080 sq. in.

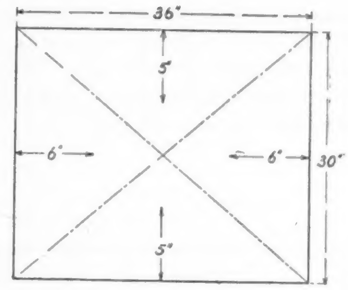
$$\frac{PA}{4} = 13\,500$$

$$XM = 13\,500 \times 5 + 13\,500 \times 5 + 13\,500 \times 6 + 13\,500 \times 6 = 297\,000.$$

NOTE: This rule applies to any form of section or surface, simply by dividing it into triangles, the center of gravity of any triangle being known; the moment can readily be found, etc.

$$T = 2\,500 \text{ and } t = 1.64 \text{ inches.}$$

It "T" equals 1 000 the thickness is ample, considering the flat surface from the ending of the round at the corners. The valve should be well ribbed where possible, care being taken that the ribs do not cut off the steam or exhaust passages. The hole for the valve stem is usually cored larger in diameter than the stem and of oval section, the long axis perpendicular to the face of the valve, thus allowing the valve to be forced from its seat without danger of binding and springing the valve stem.



It is necessary to leave a little play between the side faces of the valve and the inside finished strips of the valve chest. These flat side valves are almost invariably made of cast iron and as the seat is of the same metal, careful attention is necessary until they have worn to their bearing.

The sketch of the slide valve for a 68-inch cylinder, shown at "A," is the type of valve considered in this article.

The ribs A and F are so placed as not to interfere with the flow of steam. H H represents the lap of the valve.

The projections at E E hold the square washers that are on the valve stem. The strain on the top of this valve from the formulæ previously given is about 950 lbs. per square inch.

This valve is guided at the back by the guide strip and held to the face on the cylinder spiral springs forcing a shoe against the guide strip.

In closing I would say: Be careful to have ample steam and exhaust area, and an uninterrupted flow.

As light a valve as possible, yet with ample strength and stiffness. The face of the valve well scraped to a true surface and free of all blow or sand holes.

Ample lubrication and freedom from binding, and well supplied with facilities for handling on shipboard.

LOWEST COST OF STEAM POWER.

The steam plant of the Warren Steam Cotton Mill, Providence, R. I., is reported by Dr. Robert H. Thurston to have shown the best economy yet recorded, viz., $11.55 per HP. per year of 3,070 working hours. The following particulars are given by the *Engineering News:*

The engine, designed by Edwin Reynolds, of the E. P. Allis Co., Milwaukee, is cross-compound condensing, rated at 1 950 HP.; cylinders 32 and 68 inches by 5 feet stroke, making 74 revolutions per minute. The steam pressure is 155 pounds per square inch and the coal consumption is 1.35 pounds per horse power hour. Heine water-tube boilers are used. Coal costs $2.26 per ton.

The following is a tabulated statement of the cost of power:

Fuel per horse-power per year of 3 070 hours	$4.70
Labor	1.88
Supplies and repairs	.42
Total operating expenses	$7.00
Interest, at 5 per cent	2.05
Depreciation, at 5 per cent	2.05
Taxes	.41
Insurance	.04
Fixed charges	$4.55
Total cost of power per year	$11.55

The cost account includes the cost of steam used for all purposes, including banked fires, nights and Sundays, and that supplied the mill. The engine replaces a quadruple expansion engine which was destroyed by fire after seven years of service. It appears that the saving of fuel which may be made by a quadruple as compared with a compound engine is more than overbalanced by its higher first cost, when the engine is run only 10 hours a day and the cost of coal is as low as $2.26 per ton.

THE SLIDE RULE.

THE PRINCIPLE OF THE LOGARITHMIC SCALE EXPLAINED—HOW TO MAKE A COMMON SLIDE RULE—PLAIN DIRECTIONS FOR ITS USE.

A. H. Eldredge.

Among the instruments used by the engineer and draughtsman, few are of more value, as labor-saving devices, than the slide rule. At the same time the results obtained through its intelligent use are more trustworthy than those found in the ordinary methods of multiplication and division.

In the present article we will consider only the common or Mannheim form of slide rule. The desire of the writer is to interest the young engineer, and instruct him how to make, and how to use, the instrument.

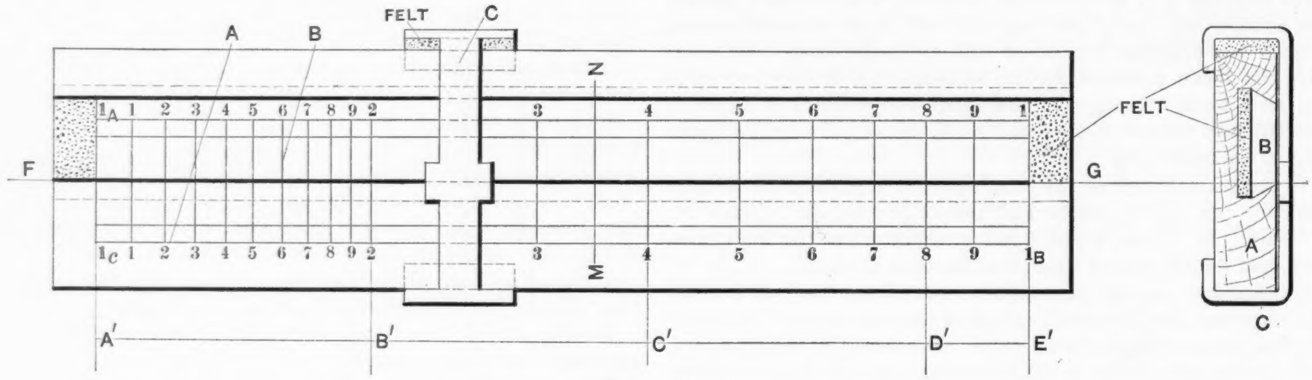


Fig. 1

The ordinary slide rule will be found to contain three elementary parts; viz., a fixed scale A, (Fig. 1), a movable scale B, and a pointer or runner C. The scales are known mathematically as logarithmic scales or scales in which a series of numbers in arithmetical progression corresponds to another series in geometrical progression. A series of numbers in arithmetical progression is any series in which each succeeding number is greater than the one before it by a fixed amount, as, 1, 2, 3, 4. A series of numbers in geometrical progression is one in which the last number in the series is multiplied by a constant number in order to obtain the next one of the series; as, taking 2 for our constant multiplier and starting with 1, we develop in geometrical progression the series 1, 2, 3, 8, 16, etc.

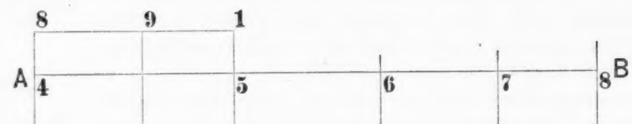
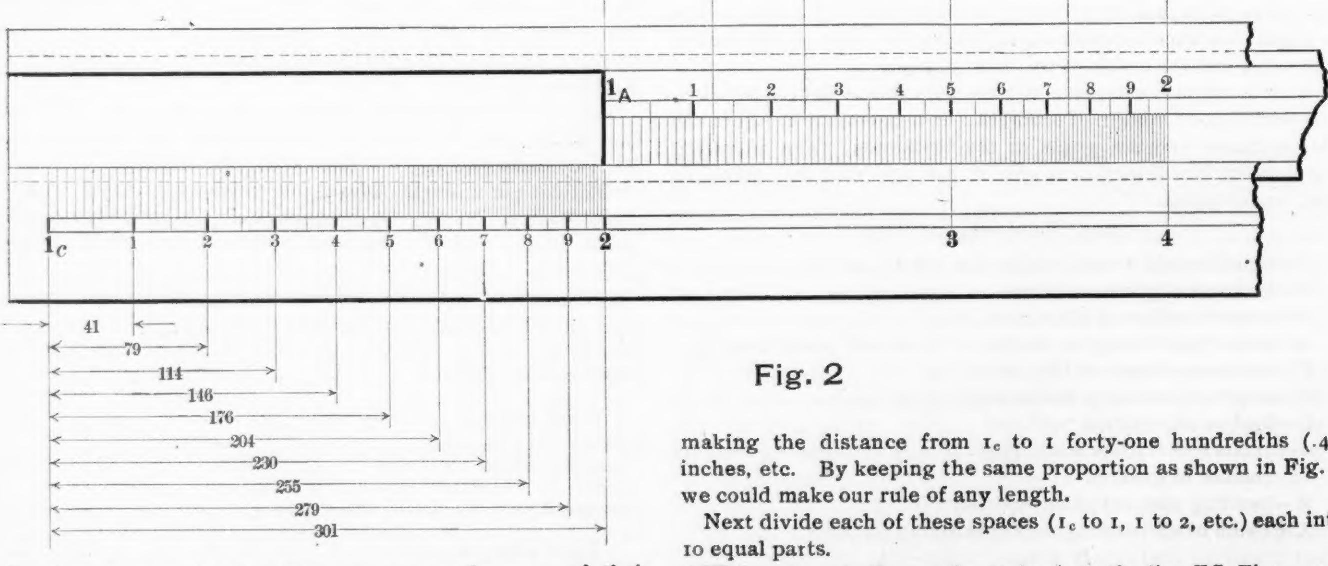



Fig. 2

Placing these series together, we can study some of their properties.

Arithmetical progression..	0	1	2	3	4	5	6	7	8
Geometrical progression..	1	2	4	8	16	32	64	128	256

Add 2 and 3—the sum is 5. Under 5 we find 32 the product of 4 and 8, the numbers directly under 2 and 3.

Multiply any number in the upper scale by 2, for example, 3 times 2; the product is 6. Under 6 we find 64, the square of 8, the number under 3. Or, divide any number in the upper scale by 2, for example, 8 divided by 2; the quotient is 4. Under 4 we find 16, the square root of 256, the number under 8. These are a few of the properties of the logarithmic scale, which might be called a scale of multiplication and division, or of powers and roots.

We may now proceed to construct the logarithmic scale of the slide rule. This should be done on the drawing-board and afterward transferred to the frame of the slide rule.

The scale can be made of any length, but for convenience we will make one 10 inches long, and proceed as follows: Draw 6 parallel lines as shown in Fig. 1 at MN and, with a steel scale divided into hundredths, lay off A^1B^1, B^1C^1, and C^1D^1 each equal to 3.01 in., and the space D^1E^1 .97 in. In these spaces we will place the numbers as shown in the series in geometrical progression at the beginning of the article, *i. e.* from A^1 to B^1 all values between 1 and 2, from B^1 to C^1 all values between 2 and 4, etc. The numbers 1, 2, 4, 8 are located at the main divisions of the scale as in Fig. 1.

How shall we locate 3, 5, 7, 9 and how subdivide the spaces between them? Start with the two scales opposite each other, as shown in Fig. 1, and, begin by subdividing 1_c to 2 of the main scale. Lay off both scales at the same time and exactly alike, as follows: Consider the distance from 1_c to 2 to be divided into 301 equal parts, then the distance from 1_c to 1 will contain 41 of those parts, the distance from 1_c to 2 will contain 79 parts, etc., and we can lay off the sub-divisions (1, 2, 3...), as shown in Fig. 2. Having concluded to use the ordinary steel scale in our work each one of these divisions will be one one-hundredth of an inch, making the distance from 1_c to 1 forty-one hundredths (.41) inches, etc. By keeping the same proportion as shown in Fig. 2 we could make our rule of any length.

Next divide each of these spaces (1_c to 1, 1 to 2, etc.) each into 10 equal parts.

With a sharp knife cut the scale along the line FG, Fig. 1, and move the scale, now called the slide, until 1_a and 2 are opposite 2 and 4 on the lower scale.

Divide the space between 2 and 4 on the lower scale the same as the space between 1_a and 2 on the slide. Then opposite 5 on the slide would be found 3 on the scale as shown in Fig. 2. Place 1_a of the slide opposite 4 of the scale (AB, Fig. 2). We now have all values from 4 to 8 to lay off in this arithmetical division. As there are 10 main subdivisions on the slide, the figures 5, 6 and 7 will be ¼ of 10 or 2½ subdivisions apart, so

that 5 on the scale comes opposite $2\frac{1}{2}$ on the slide, 6 on the scale opposite 5 on the slide, etc.

With the slide in this position, from 1_a transfer to the scale .5.— 1.—, 1.5, 2 and 2.5 and subdivide each space into 4 equal parts, that gives our scale divisions from 4 to 5. Now move the slide until 1_a comes opposite 5 and transfer all divisions of the slide to the scale. Opposite 8 of the slide will be found 9 on the scale, and opposite 2 of the slide comes 1_b on the scale. Place the slide and the scale in the starting position and divide and mark the slide the same as the scale. These scales may now be mounted on a wooden frame and a brass runner can be made, as shown in Fig. 1. The slide rule is then ready for use.

In using the slide rule, one or two points should be borne in mind: First, we can read only two or three significant figures, the rest have to be estimated. Second, the slide rule does not locate the decimal point. Should we read, for example, 536—it might represent any value. It might be 53,600 or 5.36 or .0536. We must place the decimal point by inspection or by a rough trial. A little practice soon overcomes this difficulty.

The following directions will enable us to perform ordinary examples in multiplication and division:

1st. Arrange the figures as in division with one figure more in the numerator than in the denominator, using the number 1 should there not be enough figures in the example to be performed, as $\frac{8 \times 6 \times 7 \times 42 \times 4}{1 \times 6 \times 4 \times 1}$

2nd, (*a*) Set the slide, or movable scale, so the figures are opposite those on the fixed scale.

(*b*). Set the pointer or runner opposite the first figure in the numerator as found in the fixed scale.

(*c*). Move the slide until the first figure in the denominator, as shown on the slide, comes opposite the runner.

(*d*). Move the runner until it comes opposite the second figure in the numerator, as shown on the slide. Continue these operations until the answer can be read on the fixed scale opposite the last setting of the runner.

Caution. Remember that the pointer or runner is used for multiplying and the slide for dividing.

3rd. When the sliding scale runs beyond the range of the rule, move the runner to figure 1 on the slide, then pull the slide through to the opposite end and proceed as before.

4th. To divide by a constant, bring the divisor on the slide opposite the dividend on the fixed scale. The quotient will be seen on the fixed scale opposite the figure 1 on the slide.

5th. To multiply by a constant, set the figure 1 on the slide opposite the multiplicand on the fixed scale. Opposite the multiplier on the slide read the answer on the fixed scale.

6th. The decimal point must be located roughly, independent of the slide rule.

Let us now work out the example $\frac{32 \times 16 \times 2}{14 \times 1}$, which is to multiply 32, 16 and 2 together and divide by 14. Set slide and scale opposite. Move runner to 32. Move slide until 14 on the slide comes opposite the fixed edge of the runner. Move the runner to 16 on the slide. Move the slide till 1 on the slide comes opposite the edge of the runner. Lastly, move the runner to 2 on slide and read the answer, 73.2, on the fixed scale. The number 2 or, the third figure in the answer has to be estimated from the position of the slide. The decimal point comes after 73. as found by trial. Carrying this example through in the ordinary way, we find the answer to be 73.14 +.

Let us take the example $\frac{74 \times 29 \times 2}{14 \times 1}$. Set the slide and scale opposite. Move the runner to 74 on the slide. Move the slide until 14 comes opposite the fixed edge of the runner. Move the runner to 29 on the slide—that is impossible, as 29 is beyond the scale; so move the runner to 1 on the slide and pull the slide through to 1 on the other end, and move the runner to 29 on the slide. Move the slide until 1 comes opposite the fixed edge of the runner. Lastly, move the runner to 2 on the slide and read the answer, 306.2, on the fixed scale opposite the last setting of the runner. Working this example in the ordinary way we find an answer of 306.5. Thus we see that the error introduced in the estimated figure would be inconsiderable when working many problems in engineering as, for example, the power transmitted by an engine.

With a little practice one will soon become expert in the use of the slide rule and will find the possibilities of using it for other work than simple multiplication and division.

WATER-TUBE BOILERS AND LIQUID FUEL FOR THE NAVY.

The report of the Chief of the Bureau of Steam Engineering for 1897 indicates that an important change is to take place in naval practice, and possibly in marine practice in general, in the substitution of water-tube boilers for the cylindrical boilers of the Scotch type with their enormously heavy shells. He states that the gradual replacement of this type on war vessels by various forms of the water-tube boiler constitutes the most important fact in marine engineering at this time. For torpedo boats their superiority was so evident that they quickly displaced the older type and have been used exclusively for some years.

The first instance of the use of light water-tube boilers for a large power (over 4 000 I. H. P.) was on the Monterey, in 1892. The Monterey was expressly designed for coast defense, so that she would be always near repair shops if necessary, and was thus deemed a good ship on which to try the experiment.

The Bureau now feels that with the experience gained here and abroad, the efficiency of the fleet will be best served by using water-tube boilers on future ships. As yet no specific recommendations are made for any particular type, but the report seems to favor boilers having straight tubes, like the Babcock & Wilcox, for the reason that they resemble the well-known land boiler, which is used extensively all over the world, and which has all essential features in common with a number of other well known land boilers, so that the fire-room force of our ships is more likely to have some acquaintance with this boiler than others of the type. The straight tubes can be readily removed and replaced, and can be purchased wherever engineering materials are kept in stock.

Another part of the report, which is also of interest, relates to the use of liquid fuel. It is stated that its advantages are greater evaporative power for same weight and bulk, ease of manipulation, perfect control of the combustion to suit the requirements of service, rapidity of starting fires, cleanliness, absence of refuse and the necessity for disposing of it, smaller personnel required in fire rooms, and (if it were in general use) ease and cleanliness in receiving and stowing on board. Against these advantages there are the disadvantages, if residuum is used, of cost (if adopted to a great extent), difficulty of purchase away from our own coasts, and (unless used to a great extent) some trouble in receiving on board. If other forms of fuel oil are used, some of these might be obviated, but the question of danger would arise.

As this is the greatest oil producing country it is but natural that the subject should receive attention, and in order to experiment on a larger scale than has been done before in the navy, a new torpedo boat is to be fitted for burning fuel oil, and an exactly similar boat, building by the same contractors, will burn coal, which will afford an excellent opportunity for a comparison of the two fuels.

That fuel oil has not hitherto been used for naval purposes is due to the items of cost and difficulty of purchase, except in a few localities. On the Caspian Sea, where petroleum refuse is plentiful and cheap, it has been in successful use for more than fifteen years. Experiments made about ten years ago by the Pennsylvania Railway Company showed the entire practicability of burning "reduced oil," but the question of cost made its use, except in special cases, impracticable, as well as the fact that this railway, if using oil fuel to the exclusion of coal, would at that time have consumed more than one third of the entire output of petroleum in the United States. It is therefore quite evident that, as far as can now be seen, there is no prospect of the use of fuel oil in replacement of coal on vessels employed in general cruising. It is believed, however, that a torpedo fleet, which would operate on our own coast, could use oil fuel advantageously if the cost does not prove to be prohibitory.

* * *

THE Knapp roller boat mentioned in our September issue has had its trial, and besides showing structural weakness, which resulted in leakage and in giving the machinery a salt-water bath every time the shell of the boat revolved, it developed a speed of 6 miles an hour instead of the expected 60.

PRACTICAL PATTERN MAKING.—7.

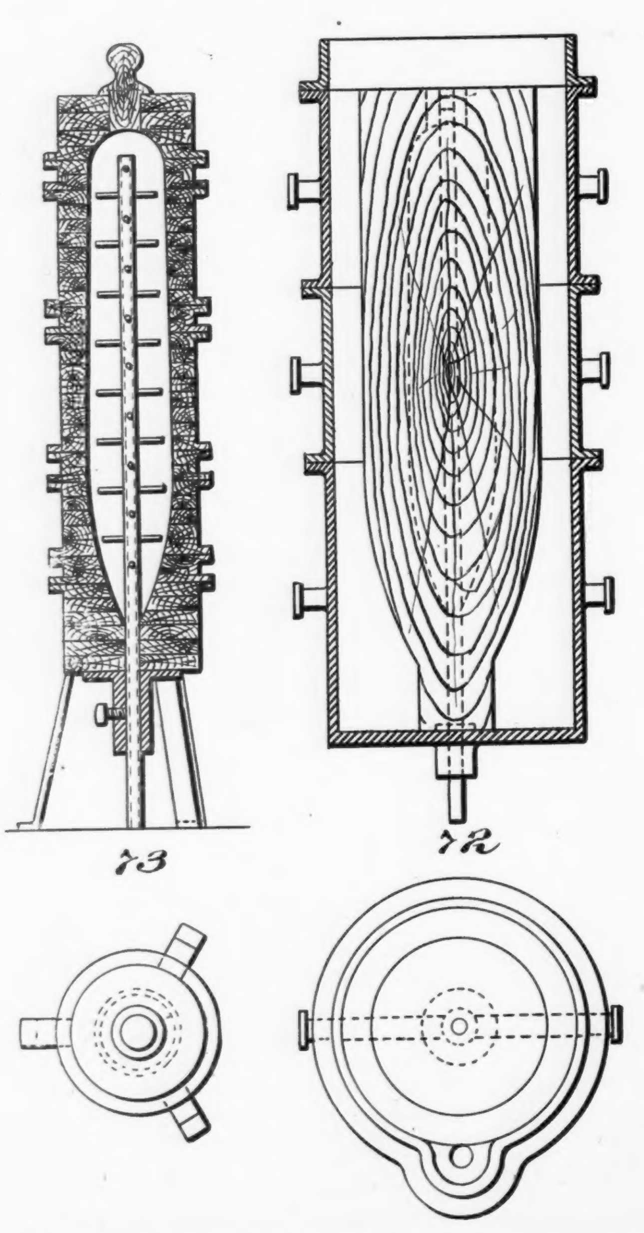
PATTERN WORK FOR RIFLE PROJECTILES.

I. McKim Chase.

Dry-sand moulding is adopted chiefly for large and intricate castings requiring solidity and accuracy of form. It is a somewhat less expensive method of producing castings than by moulding in loam, especially when the castings are to be duplicated. Dry-sand moulds are made of specially prepared sand, and are dried in an oven or a heated room; consequently metallic flasks become necessary.

Patterns designed for moulding in dry sand do not materially differ from those intended for green sand. In some cases, however, they can be formed of fewer pieces, as cores and draw-

XII

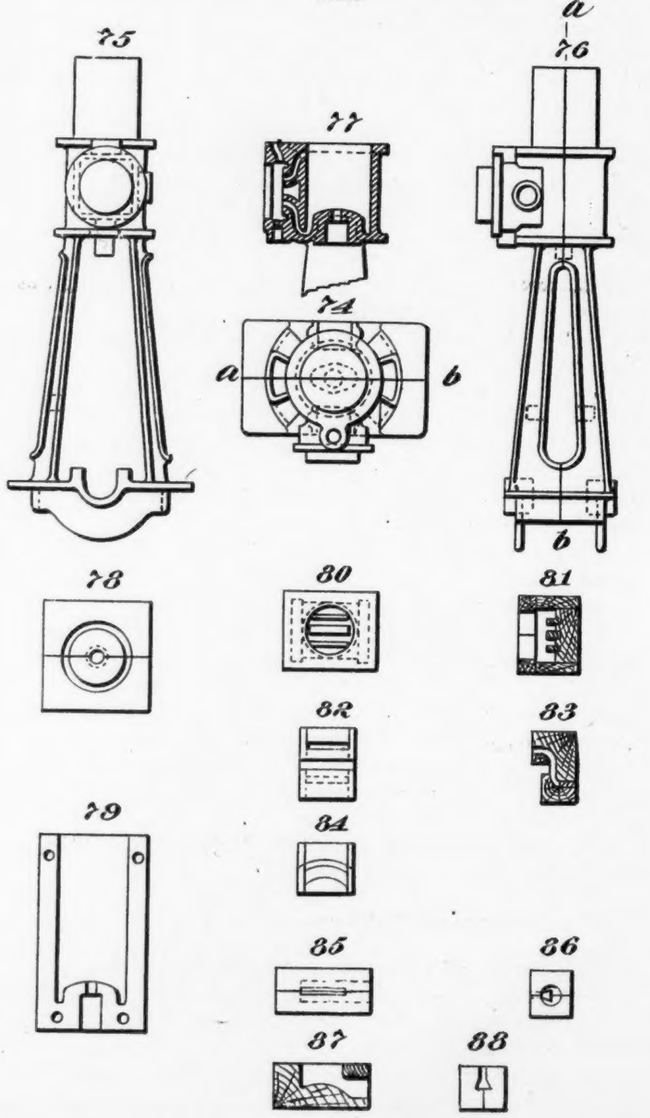


backs are frequently made in the mould of the same material as the mould itself, and to better advantage than if made in separate boxes.

Projectiles designed to carry explosives must be free from porosity to avoid the liability of the charge they contain becoming ignited by the firing of the gun, with the result of a premature explosion of the shell. When such projectiles are made of cast iron, every precaution is taken to secure dense and accurate castings. The location of the core in reference to the exterior of a rifle shell is very important. Should there be much eccentricity, the accuracy of aim is affected, and therefore the castings are required to be accurate, the tolerance of error is small. The requirements for shell castings are best secured by moulding them in dry sand.

Illustration XII. shows a 13-inch rifle shell. Fig. 72 is the pattern and 73 the core box. The pattern is made solid, preferably of bay-wood. When large, as in the present case, two or three inch lumber is glued up until the desired size is obtained. A bar of 1½-inch round iron, provided with a collar, is fitted through the center of the block and screwed half-way into a nut let into one end of the block, and the collar on the bar is let into the opposite end of the block. The remainder of the thread in the nut is for the double purpose of securing an eyebolt when the pattern is to be withdrawn from the mould, and also to secure a center when the block is to be placed in the lathe. The end of the bar projecting outside the pattern contains a center, and the pattern is swung between those centers while being turned. The projecting bar, or center pin, is also turned so as to be concentric with the pattern. The pattern which is shown

XIII



in the flask, with the position of the core dotted, is moulded in the position shown, and the draft or taper is toward the point of the shell. A cylindrical projection is made at the point of the shell to provide a sinking head.

The core box is made in sections, as illustrated, segments of bay-wood being glued and nailed in the usual manner to form them. The sections are made to match by turning a projection on one end of a section and a corresponding recess on the end of the adjoining section. The core being tapered, allows the sections to be drawn from the core in an axial direction.

The first or lower section of the core box is fitted with a sleeve, which is for the purpose of holding the vent tube concentric with the core. The vent tube performs two functions, that of carrying off the gases from the core, and supporting the core in position in the mould. That part of the vent tube covered by the core is perforated with numerous holes, and small pine sticks are placed in these holes to assist in venting the core as well as to help secure it to the tube. The shells are moulded in a vertical position in special brass flasks, made in sections to

facilitate ramming up. The first section of the flask has a cross-bar with a boss in the center of the flask; a hole through this boss corresponds with the diameter of the bar projecting from the pattern, also with that of the vent tube projecting from the core. By this means, when the vent tube is secured in the hole, the core is brought concentric with the mould. The core is set while the mould remains as when the pattern was drawn. After the core is set, the mould is inverted and the shell cast with its point uppermost.

PATTERN FOR LAUNCH ENGINE.

Illustration XIII. represents the pattern for an 8 x 8 launch engine. The cylinder, valve chest, frame and bed-plate are combined in one casting.

Fig. 74 shows a plan, 75 a front elevation, and 76 a side elevation of the pattern. Fig. 77 shows a section of the cylinder through the steam and exhaust passages. The pattern is arranged for moulding with the valve chest down, or in the drag, and is made to part through the axis of the cylinder.

In making the pattern of the cylinder it is preferable to use well seasoned lumber of thickness sufficient to allow of it being turned to the required dimensions without the gluing together of several pieces. To do this, lumber some five inches thick is required. In turning the cylinder, scores of about one-quarter inch deep are made where the flanges are located; the latter are sawed out and fitted into these scores, being there glued and nailed and finished with the remainder of the cylinder.

The open or top end of the cylinder has a core print turned there. In length it is about equal to that part of the core which enters the cylinder in order to obtain sufficient support for the core, as little can be had from the opposite or stuffing box end, in consequence of the small diameter of the core there.

The lower end of the cylinder has a cavity or recess turned in it, into which the pattern of the stuffing box is fitted. The stuffing box with its attached core print (*a*), like the body of the cylinder, is made in halves and attached to the latter by dovetails in such a manner that it can be lifted out with the main core without affecting the cylinder.

The main core is that which is formed below the cylinder and between the framing or housing and bed-plate. As commonly said, the pattern leaves its own core in that part.

The bed-plate is made by framing together four pieces of the required thickness, of width sufficient to allow the plate to be reduced to the required shape. After the plate is worked to shape and lined off, the bearings for the shaft are added, and also the ribs or flanges which project below the plate. It is then sawed through the center of the bearings with a thin saw and the two halves dowelled to make it part in the same plane as that of the cylinder.

The framing consists of conical-shape frames, placed opposite each other, and which connect the bed-plate with the cylinder. Each is made in two pieces which part in the same plane as that of the cylinder and bed-plate, viz., on the line *a b*. In fitting the framing to connect the cylinder with the bed-plate, a surface board is first prepared and lined off. The nowel or drag halves of the cylinder and bed-plate are secured to this board in their correct relative positions.

The drag halves of the frames are let into the cylinder about one and a half inches and secured there with glue and screws. At the opposite ends the frames are fitted against the bed-plate and glued to it; screws are also driven from the under side of the bed plate into the ends of the frame. A large fillet is glued and nailed around the frame and to the bed-plate, and this aids materially in making the pattern more rigid at that part.

The drag halves of the cylinder and bed-plate being secured to the framing, the pattern is released from the board and turned over; the cope halves of the cylinder and bed-plate are placed upon their drag halves, the cope framing being secured to them in a similar manner to that adopted with the drag.

The valve chest is fitted and secured to the drag half of the cylinder, the flange is fitted to the chest with steady pins, but separates from it in the mould where a parting is made to enable the flange to be withdrawn.

Figs. 78 and 79, respectively, show an end view and an elevation of one-half of the core box for the cylinder.

Figs. 80 and 81 show a plan and a section of the core box for the valve chest.

Figs. 82, 83 and 84 show a plan, a section and an end elevation of the core box for the steam passages.

Figs. 85, 86, 87 and 88 show a plan, an end elevation and a longitudinal and transverse section of the core box for the exhaust passage.

In moulding the pattern, which is done in an iron flask, the drag part is laid upon a follow board, and a box representing one-half the main core is put between the frame to form the parting there. The mould is rammed up to the face of the valve chest flange, a core is placed over the flange to cover it, and the mould is then continued until it surrounds the core. The latter is then removed and the pattern of the flange taken out, after which the core is replaced and the ramming of the drag completed. The flask being turned over, the box representing the main core is removed and a lifting plate for the core is placed in the bottom of the space it formerly occupied. The main core is built upon the plate up to the parting. The cope half of the pattern is now placed in position and the main core is continued to completion. The cope of the mould is next completed and removed with the cope part of the pattern, leaving the stuffing box in the main core. The latter is now lifted out and the stuffing box removed from it. The main core being out of the way, the drag half of the pattern is withdrawn from the mould.

More than one hundred castings have been made of bay-wood from a single pattern, as thus described.

LEVEL HEADED.

Mr. Editor: A machine shop level ought to be about 18 inches long to be of the most general utility: it ought to have a carefully ground glass, carefully mounted, with adjustment at each end; it ought to indicate a thickness of tissue paper in its length, which means that it ought to show when a surface is out of level .001 of an inch to the foot. It ought to be adapted to plumbing as well as leveling, the bottom ought to be grooved so that the level could be used on shafting, and the outer edges along the bottom ought to be true so that the bore of the guides of an engine bed, for example, or any other bored work, could be tested.

Such, in brief, is the way machine shop levels ought to be made, but it is the way they are not made, because if they were they would be too good and would cost too much and nobody would buy them.

Then such a level ought to be kept in the tool room *for use* and not to look at, and its use ought not to depend upon a written order from the foreman, either. There is such a thing as keeping nice tools too nice and rough tools too rough—both go together, because if there is not enough system and responsibility in the tool room to see to it that the best tools are returned in proper shape before the checks are given back, without any permit for their use from some higher authority, then the poorer tools will have to catch it right and left every time they are given out.

The level is not used in the shop half as much as it might be, and no wonder! The average level as we find it wouldn't plumb a brick wall ten feet high within half an inch, and it is about as good as a pail full of water for leveling a planer bed or piece of work, and often not much better. Not long ago I had an extra fine job to level up and spent three hours in a big store in a big city—no names stated, as it might be too personal—trying to find a level that would do the business. I went through every level in the store, good, bad and worse, and some of them were so slow that they almost forgot to move when stood up on end, some stayed right where they were with a piece of cardboard under one end, some would rock, some were hollowing, and the best one of all was a cheap carpenter's level that cost a dollar and a half. I finally selected a small level, pocket size, that seemed to be fairly sensitive and that could be set on a straight edge in lieu of more length of body.

It doesn't do much good to kick about shop matters that are not as they ought to be, because if one made a practice of it he wouldn't have time for anything else. But no great thing was ever accomplished without kicking, and it *would* be a great thing to have a few good levels where they were handy—at least, such a state of affairs would be appreciated by one humble

Foreman.

* * *

It is estimated that during the past year 650 000 000 passengers were carried in steamships, and the number of accidents resulting in the loss of life was 26. The number of lives lost was 183, of which 46 were passengers and 137 employees.

THE INKING OF DRAWINGS.

The India ink used in mechanical drawings comes in two forms —stick and liquid. The former is imported from China and Japan. It is a mechanical mixture of fine lampblack and glue, to which is added a small percentage of camphor. It is placed upon the market in the form of a stick, and varies in price from fifteen cents to twelve dollars a piece, according to size and quality. The Chinese laundrymen in this country use ink in the form of a cylindrical piece about five inches long and an inch in diameter, covered with tinfoil. The size permits of grasping firmly when grinding and the tinfoil protects the hand. This ink has been found to give good results when used for inking

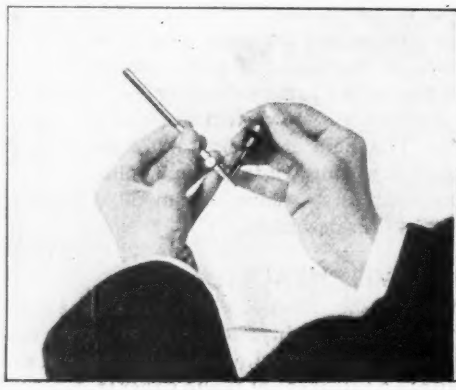


FIG. 1.

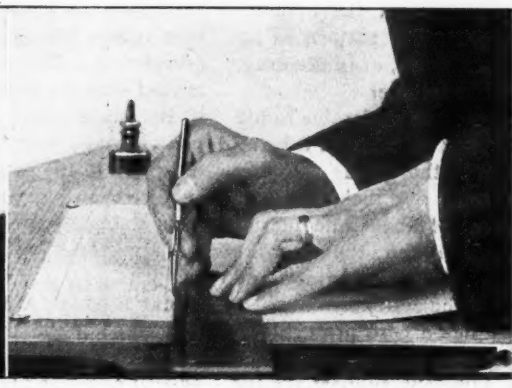


FIG. 2.

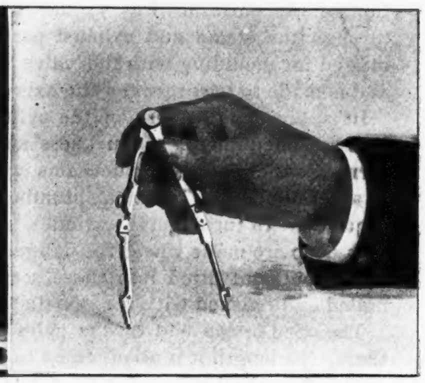


FIG. 5.

mechanical drawings. One piece will last almost indefinitely, and can be purchased at a Chinese laundry at from twenty-five to fifty cents a stick. The ink is mixed for use by grinding with a little water upon a smooth surface.

A more convenient though more expensive medium for inking is furnished by the liquid inks that come in bottles at the uniform price of twenty-five cents a bottle. The cork of the bottle is generally provided with a device to assist in filling the pen. The method of filling with such a device is shown in Fig. 1. Inserted in the cork is a quill to which sufficient ink adheres to fill the pen. The pen is held in the left hand in the position shown and the ink dropped between the nibs of the pen by contact between the quill and the pen. The column of ink should not be more than one-quarter or three-eighths of an inch in height. More ink than this flows too freely and causes blotting. Keep the outside of the nibs at all times bright and clean.

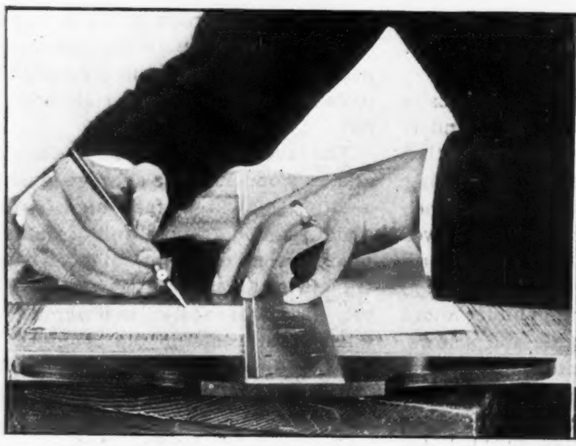


FIG. 3.

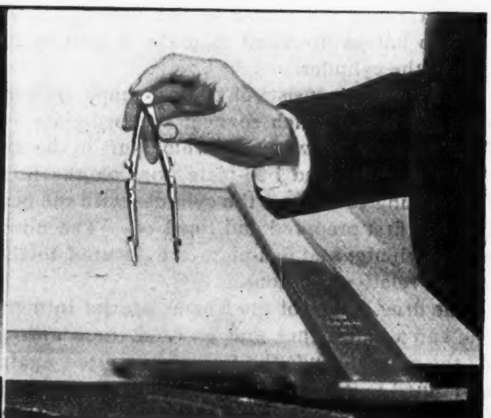


FIG. 4.

In inking, the T square and triangles are used to steady and direct the pen. Fig. 2 shows the position in which the pen is held when drawing horizontal lines. It should be held in the plane of the edge of the T-square. The curvature of the point of the pen is sufficient to prevent blotting by contact with the T-square. Blotting of this kind is caused by inclining the top of pen away from the person. Fig. 3 shows another view of the hand when using the pen, and illustrates the proper inclination at which the pen should be tipped. The pen is drawn along slowly without pressure of any kind. The weight of the pen is sufficient to cause the ink to flow. Avoid grasping the nibs convulsively between the fingers. The pen is adjusted to the desired thickness of line by the screw connecting the nibs. All full lines should be drawn firmly and smoothly and of sufficient weight to make a contrast between them and dimension or construction lines. These later should be as fine as is consistent with legibility. Ink should not be allowed to remain in the pen when not in use. In inking, draw all curved lines first, then the straight lines.

A method of holding the compasses is shown in Fig. 4. It will be noticed that the compasses are slightly inclined toward the direction in which the curve is being drawn, and also that the lower halves of the legs are nearly parallel. The compasses should be grasped lightly, in the manner shown, and rotated in the direction of the hands of a clock.

A method of adjusting the compasses is given in Fig. 5. This permits of adjustment with the use of but one hand. Avoid grasping a leg of the compasses in either hand and then opening and shutting until the desired adjustment is attained. L. R.

THAT WORM GEAR PROBLEM.

A FAMILIAR PRINCIPLE EXPLAINED FOR YOUNG MECHANICS—NOTES ON THE EFFICIENCY AS AFFECTED BY FRICTION.

RETSEL.

The correspondent who wrote in the last issue under the title "Something to Think About," and who desired to have the subject of the efficiency of worm gearing discussed, has presented some problems which, while of interest and practical value to mechanics, do not seem to be susceptible of very exact solutions.

He points out that variations in the amount of wearing surface, pitch of worm, number of teeth in the wheel, diameters of the worm and wheel, etc., will produce changes in the efficiency, and asks for information telling how such changes affect the results and what proportions are the best to use.

The efficiency of worm gearing, like the efficiency of any other piece of mechanism, or of any machine, depends entirely upon the frictional resistances to be overcome, and as friction is something that, as far as is yet known, follows definite laws in a very irregular manner, the subject of efficiency is not an entirely satisfactory one to deal with.

As the writer in the last issue asks to have whatever is written on the subject stated in a very clear manner for the benefit of any young mechanics who may follow the discussion, it will do

no harm to devote a little space to the above mentioned fact regarding the influence of friction.

A FUNDAMENTAL PRINCIPLE OF MECHANICS.

In the first place let us define the units that we have to deal with so that there may be no confusion with regard to them. Any piece of mechanism is operated through the action of a moving force. The definition of a force is simply that of a pull or a push. The pull exerted by the driving belt of a shaper, for example, is the driving force tending to operate it, and the push exerted between the tool and the metal in cutting is the resisting force tending to stop the machine.

When a push or a pull—that is, a force—moves through a distance and overcomes a resistance, *work* is said to be done. The mechanical definition of work is the overcoming of a resistance through a distance, and the term work, therefore, implies both force and motion. The pull of the shaper belt moves through a distance in turning the pulley, and the push exerted by the tool moves ahead as the cut progresses.

Now it is evident from what we know by observation that the force acting in the shaper belt is much less than that exerted by the tool. A pull of perhaps 50 pounds would be sufficient to move the belt while it would take a very strong man indeed to move the tool through the metal by taking hold of the shaper ram, even when running with a light cut. The same thing is seen in nearly any other machine. With a crane, for example, one man exerting a force of a few pounds may be able to raise a weight of several tons.

While the forces applied to and exerted by a machine may thus be different, it is a universal principle of mechanics, true without exception, that, neglecting frictional resistances, the *work* put into a machine must equal the work done by the machine. In the case of the shaper, suppose it to be geared 30 to 1 and that there is a belt pull of 50 pounds. While the tool was moving one foot, the belt would travel 30 feet, and the work done by the belt would be $30 \times 50 = 1\,500$ foot-pounds; foot-pounds being the unit used to measure work. With no frictional loss, the work done by the tool in the same time must be 1 500 foot-pounds, and as it moves one foot the cutting force must be 1 500 foot-pounds. Also, in the case of the crane, the force exerted by the man times the distance through which it acts, must, neglecting friction, be equal to the weight raised times the height it is lifted.

Returning, now, to the worm gearing, the correpondent assumed that the worm was to be mounted on a shaft (No. 1) at right angles to a shaft (No. 2) on which was mounted the worm wheel; and that a known amount of power was to be applied to the first shaft and measured at the second by a cord wound around it, to which a weight was attached. Applying our universal principle to this device, it would make no difference what arrangement or proportions of pitch, diameters, etc., were adopted, if there were no friction present, and the work applied to shaft No. 1 would in every case be equal to the work done in lifting the weight attached to shaft No. 2. The efficiency of any device, therefore, friction neglected, is unity, since the work given out by it is equal to the work put in. As friction is always present in greater or less degree, however, part of the applied work is absorbed by it and the actual efficiency of any piece of mechanism is always less than unity.

EFFICIENCY, FRICTION CONSIDERED.

As a contribution to the subject under discussion I should like to call attention to the valuable results that were obtained by Mr Wilfred Lewis, from a series of experiments on the efficiency of gearing which he conducted for William Sellers & Co., and presented to the American Society of Mechanical Engineers in 1885.

In his experiments he used worm wheels of 39 teeth and $1\frac{1}{2}$ inch pitch, and worms with both single and double threads. He also experimented with four spiral pinions having respectively 1, 2, 4 and 6 teeth. These different worms and pinions therefore had threads of different angles, thus giving an opportunity for studying the effect of these angles. The worms and wheels were of cast iron, the worms running in oil. The thrust was taken by a button bearing at the end of the shaft, except in one instance when it was taken by the annular surface at the end of the thread. It was found that when the pressure was not great enough to produce overheating or cutting, the efficiency increased with the speed, and that the best results were obtained at a velocity of sliding of about 200 feet per minute.

The following results are abstracted from the diagram given by Mr. Lewis:

TABLE SHOWING THE EFFICIENCY OF WORM AND SPIRAL GEARING FOR DIFFERENT SPEEDS AND ANGLES OF THREADS.

Angle of Thread.	Velocity at Pitch Line in Feet per Minute.				
	3	15	50	100	200
5°	.34	.49	.625	.70	.765
7°	.425	.575	.605	.765	.817
10°	.515	.65	.76	.82	.865
15°	.61	.73	.825	.872	.90
20°	.67	.77	.86	.90	.92
30°	.75	.84	.90	.93	.945
45°	.81	.89	.935	.955	.965

From a theoretical standpoint it can be shown that a screw with a thread of 45° will give the highest efficiency. The same reasoning applies to worm gearing, and this result seems to agree very well with the results in the table. Mr. Lewis states, however, that he should not recommend an angle greater than 30°, owing to the severe side thrust on the wheel from a thread having the greater angle.

In his treatise on machine design, Prof. Unwin deduces formulas for calculating the efficiency of worm gearing, and states that the efficiency is greater the less the diameter of the worm. This is also in accord with the above results, as with the same pitch a decrease in the diameter of the worm means an increase in the angle of the thread.

EFFECT OF LUBRICATION.

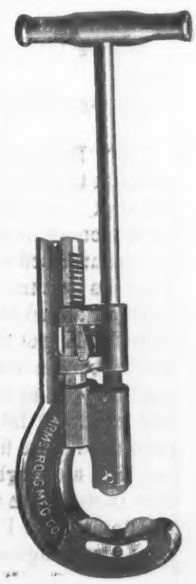
Interesting points to note are that in his calculations Prof. Unwin takes no account of speed—the very element that Mr. Lewis found so important—and his results in general seem to be lower than those given by Mr. Lewis. This may be accounted for, however, by the fact that the coefficient of friction assumed by Prof. Unwin (.15) is better adapted to surfaces only slightly oiled than to those flooded with oil, as was the case with the experiments. When oil is used freely, the friction depends more upon the nature of the lubricant than upon the nature of the surfaces in contact, and the friction follows more or less closely the laws of fluid friction; when the surfaces are nearly dry, however, the friction approximates more nearly to the laws of the friction of solid bodies. The laws of solid and fluid friction are quite at variance, as will appear from the following:

Solid Friction.	Fluid Friction.
Proportional to pressure.	Independent of pressure.
Independent of areas of rubbing surface.	Proportional to areas of rubbing surfaces.
Independent of velocity of motion.	Proportional to square of velocity.

If it is desired to make fine distinctions, therefore, who can tell whether a worm and wheel designed for the highest efficiency when running in oil would also give the highest efficiency when running nearly dry?

A far more important influence than that of lubrication is exerted by the thrust bearing, which may consume a large or small percentage of the total power, according to its design. Mr. Henry R. Towne has stated that he has made experiments in which the substitution of a roller thrust bearing for an annular bearing of the ordinary form showed an increase of 50 per cent. in the total efficiency of the gearing.

A NEW ARMSTRONG PIPE CUTTER.



The engraving shows an improved form of the No. 3 pipe cutter manufactured by the Armstrong Mfg. Co., Bridgeport, Conn. This tool is very strong and rapid and is also inexpensive, and will take from $1\frac{1}{8}$ inches to four inches inclusive.

The change from the smallest to the largest size is made by simply raising a pawl and allowing the hooked bar to slide outward. To change to a smaller size the hooked bar is pushed in to the required size, when it is ready to cut. The thread on the handle is only used to follow up the cut as the cutter is revolved about the pipe. The cutter may be changed from a three-wheel to a one-wheel cutter by simply substituting rollers in place of the two cutter wheels at the end of hooked bar.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

ANNOUNCEMENT.

The usual shop kinks and practical ideas sent in competition for the prize offer are omitted from this issue because of the large amount of similar matter which is given in the Cincinnati shop notes. Their publication will be resumed in the next number.

The first prize of Usher's Modern Machinist or Grimshaw's Shop Kinks, for the best idea under this heading in the November number, is awarded to Harry Gunther, San Antonio, Tex., for "Reamers with Inserted Blades." The second prize of a year's subscription to MACHINERY is awarded to C. F. A., for "Finishing Work—Boring Eccentric Straps."

A NEW ARRANGEMENT.

Instead of the prizes heretofore offered, we will pay from 25 cents to one dollar for each kink or practical idea hereafter sent us that is worth publishing in this column. By this arrangement everyone will receive full value for any contribution which he may send. In judging the value of a contribution we shall be governed solely by its actual value to the readers of the paper, and not by its length or the labor involved in its preparation.

This department is already of great interest and value to mechanics, but we hope to make it more so. Let every mechanic who reads this send in *one* idea—and more if he can.

AN EXPLANATION.

In the last issue, in connection with our illustration of the "Jim Crow" tool holder, we asked for an explanation of the origin of the term. Numerous friends have favored us with letters of explanation, of which we print one, together with the following from *The Engineer* (New York):

"Our friends need not go to England for an answer; they can get it right here. 'Old Jim Crow' was a very popular song forty odd years ago, when this idea was first brought out, and the refrain of it was 'Turn about and jump about, and do jess so.' This obviously applied to the tool, so far as turning about went, but we are grieved to say that it did not always 'do jess so,' for when the tool came about face, on the back stroke, it came with a jerk, and the tool recoiled on the check or stop, so that sometimes it took a cut and at other times it didn't; sometimes it took two cuts at once, or a double cut, and then there was a lot of fun for the planer-man; all the tools jarred off the planer and all the belts came off. We know this is so, because we had a 'Jim Crow' rig in the old Lowell machine shop, when we were there in 1854-55."

The letter is as follows:

On page 79 of your last issue you show a Jim Crow tool-holder and want some light on how it got the name, which I think I can furnish. It comes from an old negro song and dance melody and as near as I can recollect, the words were as follows:

I whirl about, turn about,
And every time I turn about
I jump, just so;
And every time I whirl about
I jump, Jim Crow.

Hoping this will ease your mind and give you a good night's rest. JNO. W. HARTNESS.

Springfield, Vermont.

A LETTER FROM OHIO.

DEAR BROTHER: I note your wail about the decline of machine trade in the East, and while I think you exaggerate (you always did that, you know) it a little, there is considerable truth in your letter concerning it, and since my visit East last winter I am not much surprised at it. You build some nice tools in the East, perhaps the best in the world, and you get a big price for them or you couldn't afford to make them, but when it comes to regular machine tools, not requiring extreme accuracy or finish, we can lay you over the coals and win every time. You have freights against you, to be sure; but on the other hand you have the best and cheapest labor in the world, cheapest in the sense that a man does more fine work for a dollar than anywhere else I know of. But although you build good tools you don't seem to know how to use them to advantage or to hustle work as we Westerners are doing, and I'll cite a few cases to prove it. I went into a good sized engine shop where they were boring a large cylinder, 44 or 46 inches and perhaps 7 feet long. The bar wasn't over 8 inches in diameter, and though they had *three places for tools*, only one was used, and that was "scratching" away at a snail's pace, not over 3 feet a minute and springing badly on account of the small bar. In any Western shop you'll find a larger bar than that for an 18-inch cylinder, and they bore and face an 18 by 24 inch cylinder in about six hours.

Ingenious little "fixtures" abound in the East, but there is a point where these makeshifts are expensive, and should be replaced by permanent machines. This is New England's great failing. You have brighter mechanics probably than any other place on earth (Ohio not excepted), but you stick to using little jiggers on your work instead of building tools for it. You build tools for others and keep the little jiggers yourself.

Then again you have too much affection for old scrap tools, tools that your grandfather bought from Noah. They are good curiosities and ought to be preserved in a museum, but no shop that wants to earn money can afford to have them around. The best tools are none too good as money earners; the scrap heap tools eat into profits more than you realize.

Of course we have the advantage of having newer shops, but there's nothing to prevent you using some of the tools you build instead of selling them all. Its a good deal like the farmer who sells his cream and lives on skim milk. This "skim milk" economy is more disastrous in the shop than on the farm. I s'pose you'll be ungrateful for this good advice, but you'll earn more money next year if you follow it. Think it over, James, my boy, and profit by it. YOUR BROTHER "BILL."

Springfield, Ohio.

WIDE BELTS.

The Editor has asked me to make my reply to "M. E.'s" communication in October MACHINERY as short as possible, on the ground that the subject is not of general interest.

As far as discussing the difference between "centrifugal force" and "centrifugal tension" is concerned, I agree with him.

As, however, the other matters could not be handled in short space, and as my records of about 2,000 belt tests extending over some years, and made ten or fifteen years ago, are boxed up in a vault 4,000 miles away, I retire, leaving "E.M." the last (as he had also the first) word. ROBERT GRIMSHAW.

Dresden, Germany, Oct. 23.

NAMES ON MACHINE FRAMES.

Nothing looks worse than to see the maker's name cast on a machine frame in a slovenly way, with poorly chosen letters, especially when care has been taken in proportioning and finishing the other parts so that the whole, with the exception of the name, is agreeable to the eye. Some makers attempt to remedy the defects in lettering by gilding the letters or by lining them with light colored machinery paint; but this serves only to call attention to the defects, and if the letters are large has a cheap look which is not desirable.

In general a name-plate cast in dark bronze appears well on any machine; that is, according to the writer's idea of beauty, but many object to it because it is easily removed and another one substituted therefor. Moreover, while the ordinary name-plate looks well on heavy machinery, letters of generous size cast in the frame look better and are more in keeping with modern design.

One way out of the difficulty, which is often used, is to put a core-print on the pattern where the lettering is to come and to use a core made in a core box having the name in the bottom. The impression of the letters will then be made in the core, and when the metal is poured there is less liability of washing away part of them.

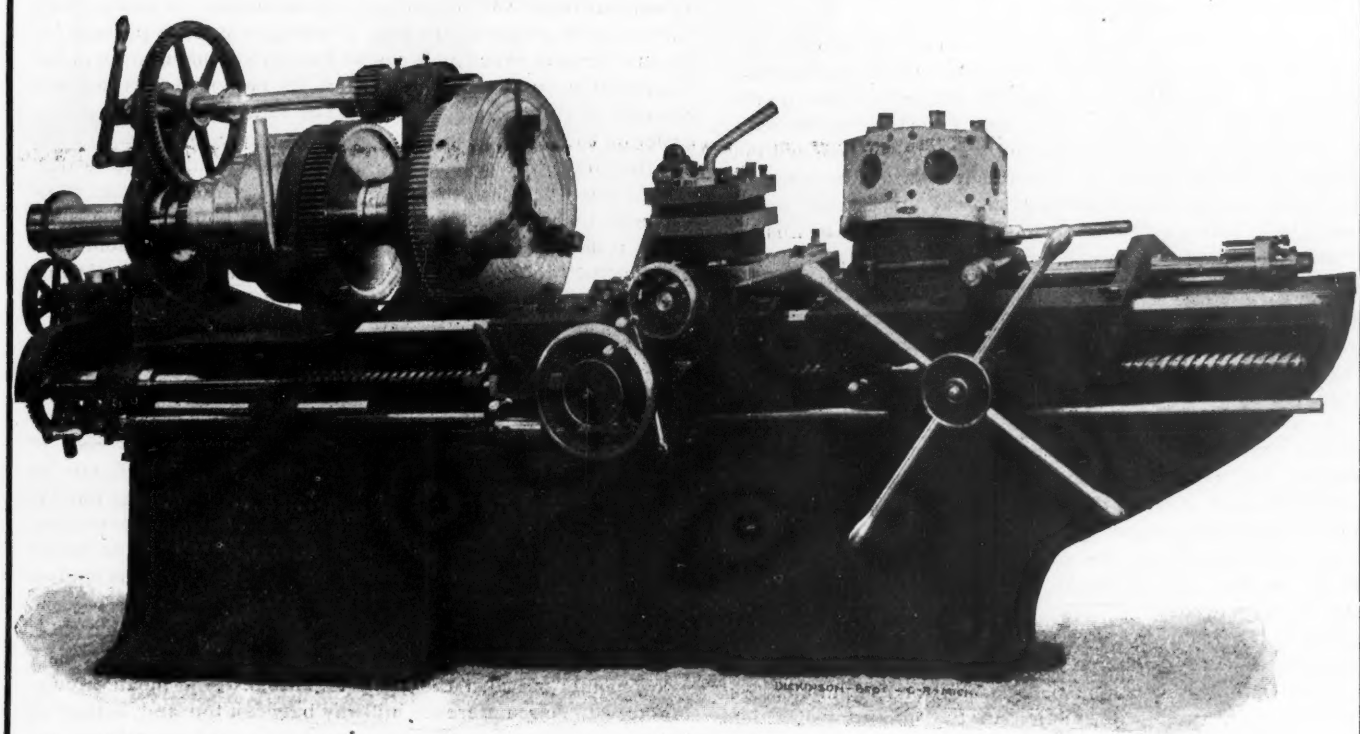
Still another method was shown the writer at Beaman & Smith's, in Providence. It consisted in using a name-plate of cast iron of a size suitable for the machine on which it was to go, and then casting a depression in the frame of the same size as the name-plate. Two flat-head machine screws, a little iron filler and some paint completed the job, and no one could tell but that the name was part of the main casting itself. This method has the advantage of always giving good, clean letters, which can be made as large or as small as wanted, to say nothing of not having to chip off a name occasionally, or throw away a large casting because some of the letters are a little too slovenly to let go. OLIN SNOW.

Wholesale vs. Retail

is the Gisholt way........is the old way.

That is, where the work is made in quantity and adapted to it, a Gisholt Lathe will do as much as two to six ordinary lathes will do. Or, to put it in another way—the Gisholt Lathe will do such work in from one-half to one-sixth the time required in the old way, depending upon the amount of finished surface on the pieces. The greater the amount of finished surface, the greater the saving.

Some of the reasons why this can be done are given below.



The Turret is mounted on an independent carriage with broad faces to which tools can be bolted, besides the usual holes for holding smaller tools and boring bars. Stops are provided for all tools. Provision is made for using broad sweep tools for facing the full diameter at one operation. Boring bars having cutters accurately set to size enter the main spindle and are thus supported rigidly at each end. Carriage with turret tool post, with cross and longitudinal feeds and stops for every tool. Powerfully driven triple-geared head. Feed motion can be instantly set for four different rates of feed, and can be changed in the middle of a cut if required. Proportions are massive and all motions powerful; 40 to 60 per cent. greater weight for the same nominal size of lathe.

GISHOLT MACHINE COMPANY,

EASTERN BRANCH, WALTER H. FOSTER, MANAGER,
126 LIBERTY STREET, NEW YORK.

MADISON, WISCONSIN, U.S.A.

GENERAL AGENTS:

C. W. BURTON, GRIFFITHS & CO., London. FENWICK FRERES & CO., Paris. SCHUCHARDT & SCHÜTTE, Berlin, Vienna.

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

30. J. B. writes: Some years since there was a project in some Eastern city or cities to melt the snow from the streets by steam. Was anything ever done in that direction, or why is not the plan a feasible one? I have a plan of my own for accomplishing the same purpose by means of a self-propelling melting tank and should be obliged for any information on the subject. *A.* You doubtless have reference to a scheme that was a good deal agitated in New York city fifteen years ago. The scheme was thoroughly impracticable, not owing to any difficulty of a mechanical nature, or the cost of the necessary appliances, but to the cost of coal and labor required for operation, which cost is prohibitive. This you may readily enough see by assuming that the annual snow fall is, say, 5 pounds per square foot of superficial area, and calculating the cost of fuel for melting it. Then there is the cost of attendance, shoveling snow, etc. The cost of keeping the streets of a large northern city clear of snow in this way would be quite enormous.

31. L. A. asks: What advantage has a double or treble thread screw over one of a single thread, and what is the pitch of such a screw? *A.* The principal reason for making a screw double or treble thread is to secure the coarse pitch and at the same time maintain sufficient bearing or wearing surface without weakening the core too much. For this reason screws are some times made 12 threaded in cases where the stock would be cut through long before as coarse a single thread could be finished The pitch of a multiple thread screw is the same as that of a single thread one, that is its linear advance per revolution.

32. J. E. G. writes: I am running a tug-boat engine which is fitted with link motion that is used for reversing only, cut-off being by means of two cut-off plates on the back of the main valve. These plates are brought close together to throw the cut-off out of operation, or separated more or less, for cutting-off at different points in the stroke, by a right and left hand screw thread on the valve stem for this purpose, the stem having a hand wheel on it outside the steam chest, for turning it. The cut-off is right going ahead but will not work backing. If I get the bell to reverse I have first to close the cut-off valves together and so lose time, which might, sometime, lead to disaster. Is there no way to arrange these valves so that they will work backing? *A.* What you describe is known as the Meyer cut-off. Where this is used for motion in one direction, the eccentric is set so as to bring about the best results for that motion, but would be quite wrong for motion in the opposite direction. Probably the cut-off on your engine is set for motion in one direction only. Place the cut-off eccentric so that its thick part is exactly opposite the crank pin. This will give the cut-off valves a motion precisely opposite that of the piston. Then the cut-off will be operative for motion in either direction.

33. L. F. N. asks: 1. What is the difference in per cent. of the braking power of a car when the wheels are made to slide or when they are just allowed to turn? *A.* It will vary with different condition of rails, whether wet or dry, etc. For all practical purposes consider that there will be no more than about one-half (50 per cent.) as much effort exerted to stop the car when the wheels slide as just before they slide. 2. Is the braking power of an engine increased by reversing? *A.* If by braking power you mean the effort to stop itself, or to stop itself and attached train, the answer is yes.

34. B. C. sends sketch of blow-off pipes and cocks from two boilers. The pipes extend laterally and downward to the sewer, by easy bends. In each pipe are two plug cocks, one being for everyday use and the other for emergent use only. He also sends a page from a technical journal on which is an engraving showing the arrangement of steam pipe from a boiler to an engine. In this pipe, near the engine, extending downward about 2½ feet, is a piece of 5-inch pipe, covered at the bottom by an ordinary cast iron cap in which is a 1-inch plug. This hanging pipe is to catch the water from the horizontal steam pipe, and was to have had a cock and drip pipe, the plug having been temporarily inserted to stop the hole. In starting the engine the cap burst, killing the engineer. The plug cocks mentioned as being in the blow-off pipes give serious trouble from leaking, and otherwise behave badly. Our correspondent proposes to put in place of the plug cocks most used, angle valves with some sort of disc other than metal, thus making a right-angle bend. He asks: Would the advantages of the angle valve counterbalance the disadvantages of the right angle bend instead of the easy bend in the pipe? *A.* No. There are no advantages in the angle valve except such as may come from a valve being better than a cock, or from the soft disc being better than one of metal. The advantage of the valve over a cock is that the valve must be opened and closed slowly while the cock may be, and generally is, opened and closed abruptly. Starting, and particularly stopping a water column abruptly, is dangerous to pipes and connections because water is one of the most solid of substances. It is well nigh incompressible, perhaps quite so, but for the small amount of air it contains. Hence anything like a blow against a water column is more destructive than a blow against a solid bar of iron. We should put in a first class straightway (gate) valve in place of the cock in everyday use. 2. Would there be danger to the pipe from the bend back to the boiler? *A.* None whatever if either the angle or straightway valve is used with reasonable care (the latter in the straight pipe as near the boiler setting wall as is practicable). A straightway valve is to be preferred because it affords a straight passage for the mud around which it is not so likely to accumulate as in the instance of an angle valve, by which its motion is arrested and changed, giving it time to settle. The straightway valve is also easier on the pipe and fittings. In the instance of the cap on the hanging pipe, the pipe was probably nearly filled with water, which, when the throttle was opened, was struck a smart blow by the in-rushing water and steam from the boiler. When such a pipe is used it should be longer than the one represented, if practicable. In any event it should be fitted with a water-line glass, which will indicate when the drip valve at the bottom should be opened; a better way still is to use a trap.

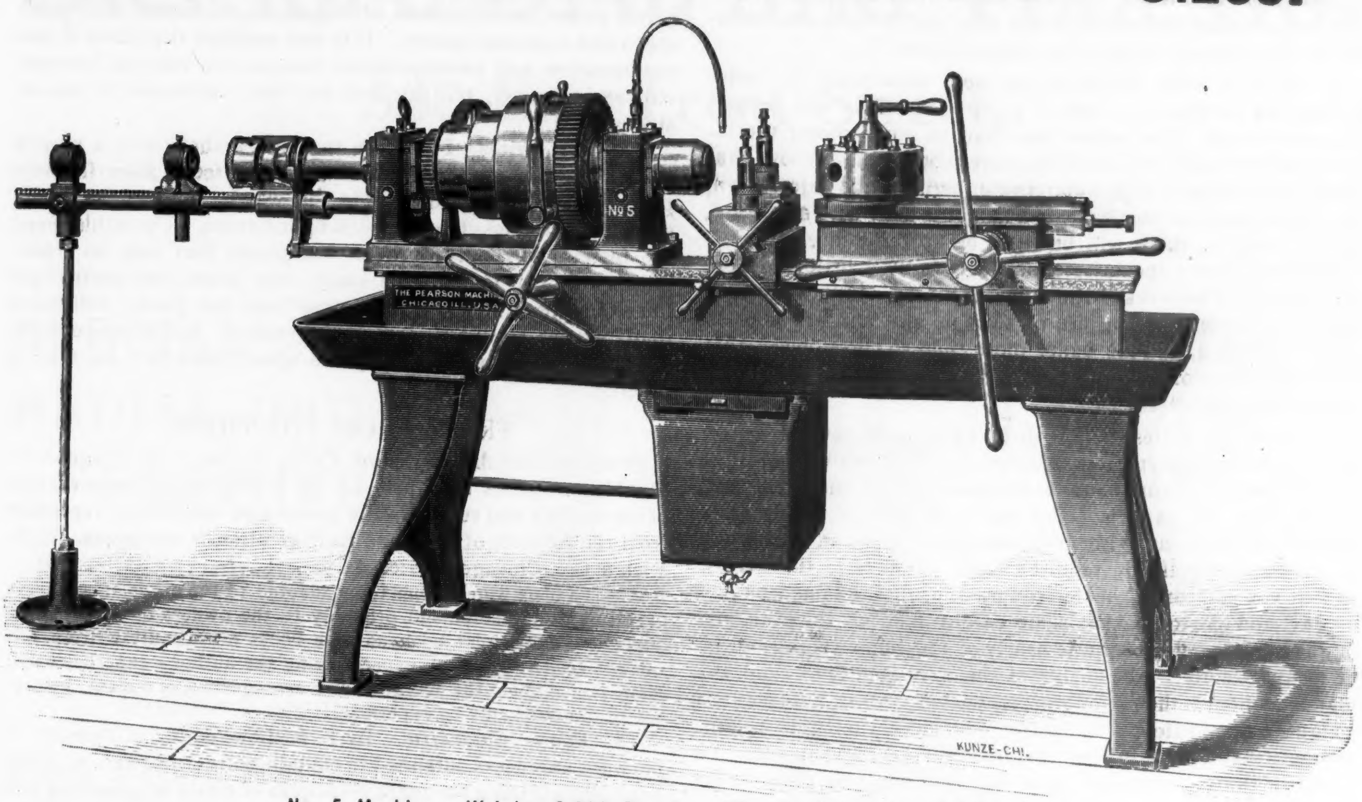
35. E. C. H. writes: I have a worm wheel to cut and would like to know how far off center, per foot, to set the index to get the angle for the cutter, the worm being 2 inches diameter, 4 pitch. Is it computed from the diameter or circumference of worm? *A.* From the circumference. We understand you to mean that the worm is 4 threads to the inch, 2 inches outside diameter. The advance is then ¼ inch (.25 inch) per revolution. The circumference of a 2-inch circle is 6.2832 inches, in which distance the linear advance is .25 inch, which would be equivalent to a set-over of .4774 inch per foot (6.2832 : 12 :: .25 : .4774). This would be right for the extreme circumference of the thread, but not right for the circumference at the bottom of the thread, or for points between the top and bottom. The mean circumference—the circumference midway between top and bottom of thread—may be taken as being 5.655 inches, and the set-over per foot will be 5.655 : 12 : .25 :: .5305 inches. In reference to this, Brown & Sharpe Mfg. Co. say:*

"To get angle of worm thread, it is best to apply protractor directly to the thread, as computing the angle affords but little help. Set gear-cutter head as near the angle as can be seen from trial with protractor upon thread; cut a few teeth; try in worm. Generally the cutter-head has to be changed before the worm will take the right position." When making trial for adjustment the few teeth need not be cut to quite the full depth.

36. W. W. asks: Please explain how the viscosity of an oil is expressed and state what apparatus is needed to determine the viscosity. *A.* The most common way of determining the viscosity of an oil is to fill a pipette up to a certain mark with the oil and then note the time it takes to run out, the temperature being kept constant. As no two pipettes are exactly alike, and as no two people would adopt the same conditions, this method is not very satisfactory for comparison of results. Various instruments have been devised for the purpose, but we are not aware that any particular one has been generally adopted. The viscosity is expressed by stating the temperature and the number of seconds required to empty the pipette. 2. Also please state whether crucible steel cables as ordinarily used on hydraulic elevators will last longer with or without grease, when used in a basement where there is more or less dust at all times. *A.* We have asked the opinion of a mechanical engineer who has de-

* "Practical Treatise on Gearing." Brown & Sharpe, Mfg. Co., Providence, R. I.

Screw Machines Four Sizes.



No. 5 Machine. Weight, 2,600 Pounds. Wire Feed Capacity, 1 3-4 inches.

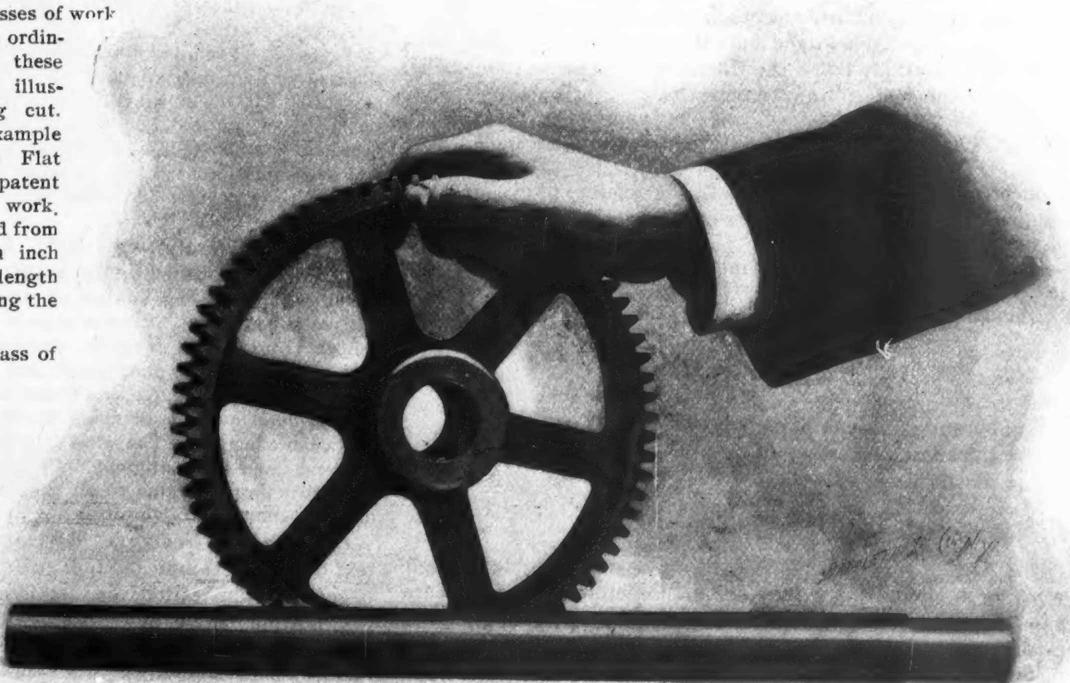
THE PEARSON MACHINE CO., 31 W. Randolph St., Chicago, Ill.

See preceding issues of MACHINERY for detailed description.

A New Lathe System—XI.

We are glad to mail our new Catalogue to manufacturers.

The Flat Turret Lathe, besides doing the ordinary kind of screw machine work, is especially adapted for two classes of work which screw machines of the ordinary form cannot do, and these two classes of work are illustrated in the accompanying cut. The lower piece is an example of the turning which the Flat Turret Lathe will do by our patent system of rapid lathe work. Duplicate pieces can be turned from the bar within 1-1000 of an inch in diameter and of any length up to 24 inches, without altering the tool.



The other piece shows a class of work that can be turned out by the use of jig tools which can be bolted to the turret, thus making the machine suited to chucking and facing gears and doing a variety of work of this kind. These jig tools form the most efficient arrangement now made for finishing small and medium sized pieces that are ordinarily done in a chucking lathe.

Of course, we can illustrate here only to a limited extent the many uses to which our Turret Lathe can be put, but we are demonstrating daily by actual use that our system is a labor and money saving one.

Don't think you are placed under any obligations to order if you ask for an estimate on your work. We tell you what we can do and leave you to decide.

THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VERMONT, U. S. A.

FOREIGN REPRESENTATIVES—HENRY KELLEY & Co., 26 Pall Mall, Manchester, England.

M. KOYEMANN, Charlottenstrasse, 112 Dusseldorf, Germany, representative for Germany, Belgium, Holland, Switzerland and Austria-Hungary.

voted much attention to elevator work; he replies as follows:

"Under the conditions named I should prefer running the elevator cables without grease. Grease will hold fast the dust and so prove more injurious. Elevator cables running at slow speed over free turning sheaves will not slip, and a lubricant therefore is not necessary as in power transmissions."

37. L. B. R. asks: Which is the more economical for boiler feeding, an injector or a steam pump? *A.* This will depend upon conditions. For boilers less than 60 horse power the injector will probably be a little the more economical. Above that power, if no exhaust feed-water heater is used, the injector will also be the more economical. If a heater is used with a non-condensing engine, there will be little or no difference. With a condensing engine the injector is likely to be a little the more economical. There is so little difference in economy, when both injector and steam pump are of suitable size and are kept in proper condition, and the boiler more than 50 horse power, that other considerations than the cost of fuel may well be allowed to govern any particular case.

38. L. C. W. writes: 1. I wish to have made several hollow cast iron balls ranging from 4 inches to 12 inches diameter. I should like to determine, quite accurately, what such balls will weigh, from the pattern. How can I do so? *A.* If by quite accurately you mean with great exactness, you can hardly expect to succeed. If you required large numbers of these balls, so that you had control of the iron used, using the same iron day by day, and employing the same careful men all the time, you might come to get them quite nearly of the same weight, but by no means exactly. The quality of the iron, quality of sand, the man who moulds them, and the core-maker, will all influence the weight to some extent. In making your calculation as to weight, estimate that a cubic inch of cast iron will weigh .26 pound. To compute the cubic inches in a ball, multiply the cube of its diameter by .5236; $12^3 \times .5236 = 904.78$ the number of cubic inches if the ball was solid. The shell is ½ inch thick, leaving a core 11 inches diameter to be deducted. That is $11^3 \times .5236 = 696.91$ cubic inches. The shell contains $904.78 - 696.91 = 207.87$ cubic inches, and may be presumed to weigh $207.87 \times .26 = 54.04$ pounds. Undoubtedly this will be the approximate weight only. To get very close to this weight will call for some change in the the core box. 2. How much internal air pressure will this ball stand, safely? *A.* For a ball of this proportionate thickness, take the radius at half the outside diameter—the outside radius. Good cast iron has a tensile strength of 20 000 pounds per square inch of section. To find the bursting pressure in pounds per square inch, multiply twice the thickness of metal by the tensile strength of the material and divide the product by the outside radius. That is $\frac{1 \times 20\,000}{6} = 3333$ pounds per square inch. For so uncertain a metal as cast iron, a factor of safety of 10 should be employed. Employing this factor of safety, the safe pressure is $\frac{3333}{10} = 333$ pounds per square inch. The algebraic expression for this is

$$P = \frac{2tT}{Rf}$$

when

P = bursting pressure in pounds per square inch.
t = thickness of metal.
T = tensile strength of material.
R = outside radius, and
f = factor of safety.

39. A. K. writes: I am interested in the steam engine through working in shops where they are manufactured. A few years ago I used to read a good deal about the economy of high speed engines, by which I understand engines of short stroke, but high piston speed. What I should like to ask is: 1. From which type of engine, the long stroke or the short stroke, have the best economic results in the use of fuel been obtained? *A.* So far as the record goes, the best economic fuel results have been obtained from engines of comparatively long stroke. 2. What is the reason? One undoubted reason is the greater loss from clearance in the instance of the short stroke engine. In most short stroke engines the actual clearance is not only larger than in the best modern long stroke engines, but the more numerous reciprocations increases the number of times in a given period that this affects the results. There is also a slight loss in friction every time a center is passed, and this occurs oftenest in the short stroke engine. Outside the economy of coal consumption, the high speed engine requires a much lighter fly-wheel for a given power and closeness of regulation, occupies less plant space and costs less money. It is also assumed that there is less condensation and re-evaporation because the interval between strokes is shorter, but this has not been satisfactorily demonstrated.

40. C. J. writes: I propose to drive a shaft with a manila rope. The distance between shafts is 80 feet. How fast is it practicable to do good driving in this way? *A.* Give the rope a speed anything less than 4 500 feet per minute. Up to this speed the faster you run the greater the power that may be transmitted. If you exceed this speed very much, the centrifugal force tending to urge the rope away from the pulley, will more than balance the gain from higher speed. All things considered, it would be wise to keep the speed down to 3 000 feet, if practicable.

FRESH FROM THE PRESS.

Practical Ice Making and Refrigerating. By Eugene T. Skinkle. A series of papers on the construction and operation of ice-making and refrigerating plants and machinery, reprinted from the columns of "Ice and Refrigeration." 220 pages. H. S. Rich & Co., Chicago. Price, $1.50.

This is a book which seems to be adapted to the needs of engineers of refrigerating plants, and probably to the owners of such plants, also. It is not a text book, as such books are usually written, but rather a series of popular papers giving the author's experience and many points about the operation and arrangement of a plant, such as can be obtained only by experience.

The Power Catechism. By F. R. Low, editor of *Power.* A book for engineers intended to contain correct answers to direct questions covering the main principles of steam engineering and the transmission of power. 226 pages, 8vo., illustrated. Price, $2.00. The Power Publishing Co., 146 World Building, New York.

The bulk of the matter contained in this volume appeared originally in *Power*, but it was revised and extended before being put in book form. There are 761 questions in all, with their answers, besides many tables, and the subjects dealt with include the classification, setting, and strength of boilers, boiler fittings and attachments, feed-water heating, combustion and firing, heating surface, chimneys, piping, horse-power of engines, slide-valve, Corliss engine, and notes on engines in general. There is also a chapter on steam, and one on belting and shafting.

In general, we think as good results cannot be obtained with a catechism as with the ordinary kind of book. More room is required for presenting a given amount of information where questions and answers are both printed, and in the exposition of principles one is hampered by the fact that each answer must deal with a single topic. However, this form is liked by many and Mr. Low's book is well gotten up, is concise and clear, and will be appreciated by any engineer.

Dies and Die Making. By J. L. Lucas. 100 pages, 8vo., illustrated. Published by the author, Providence, R. I.

This book treats of a subject on which little or nothing has been written in book form. Parts of some of the articles have appeared in the *American Machinist*, but we understand that the work is mainly new. It treats of the plain punch and die, blanking and compound dies, drawing dies, double action and sectional dies, burnishing dies, etc. General methods of doing work are explained, illustrated by particular examples. The work is fully illustrated and the cuts are well executed from original drawings. It is a book that will undoubtedly prove of value to all engaged in this line of work, or who desire to know more about it.

Essentials of Gearing. By Gardner C. Anthony, A. M. A text-book for technical students and for self-instruction. 84 pages with illustrations and 15 folding plates. D. C. Heath & Co., Boston. Price, $1.50.

This is the third of the Technical Drawing Series of which Prof. Anthony is the author, and the same method of dealing with problems is followed out in this as in the other volumes. By this method a definite layout is given for each problem, with a statement of the conditions from which the student can complete the drawing along original lines without being compelled, or having the chance, to do any copying.

It is essentially a book for the drawing room, but the principles of gearing are concisely explained so that the theory, as well as the method of laying out gear blanks, and the profiles of teeth, will be thoroughly understood.

The formulas for all the necessary calculations pertaining to spur,

Bickford Drill and Tool Co.

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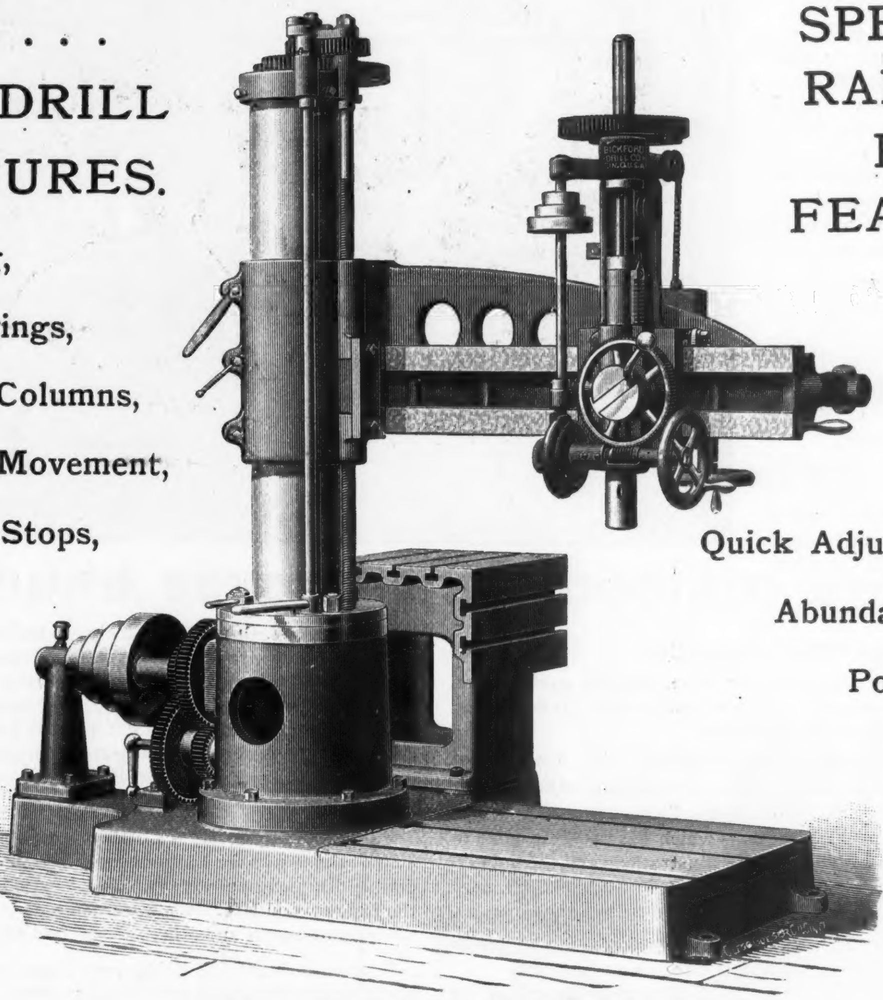

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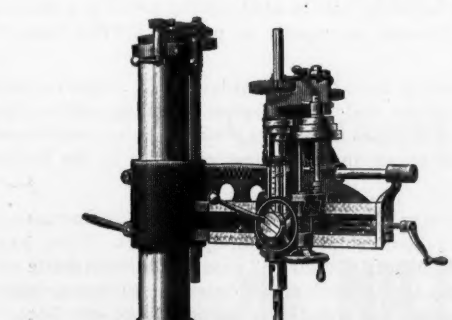

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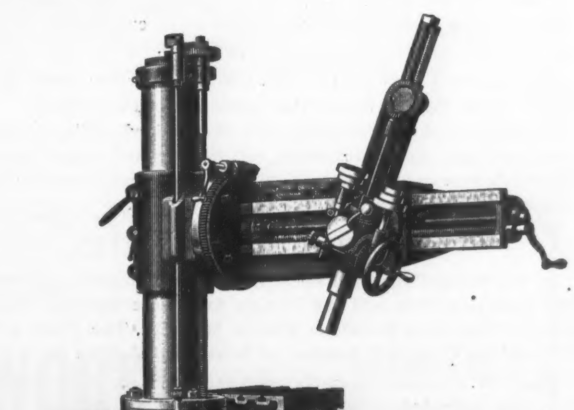


UNIVERSAL RADIAL DRILL.

bevel and worm gearing are tabulated in convenient form; references are made to practical shop articles upon gear cutting; a list of reference books is printed, and Grant's bevel gear table is given to aid in laying out bevel gear blanks. We believe the author would have done well to have also included Grant's odontograph for drawing tooth curves. Our experience with this odontograph is that it is more accurate for teeth of ordinary size than the method of laying out the true curves point by point.

The book is beautifully printed, bound and illustrated, and seems to be well adapted to the class room, for which it is intended.

A System of Easy Lettering. By J. Howard Cromwell. Published by Spon & Chamberlain, 12 Cortlandt Street, New York. Price, 50 cents.

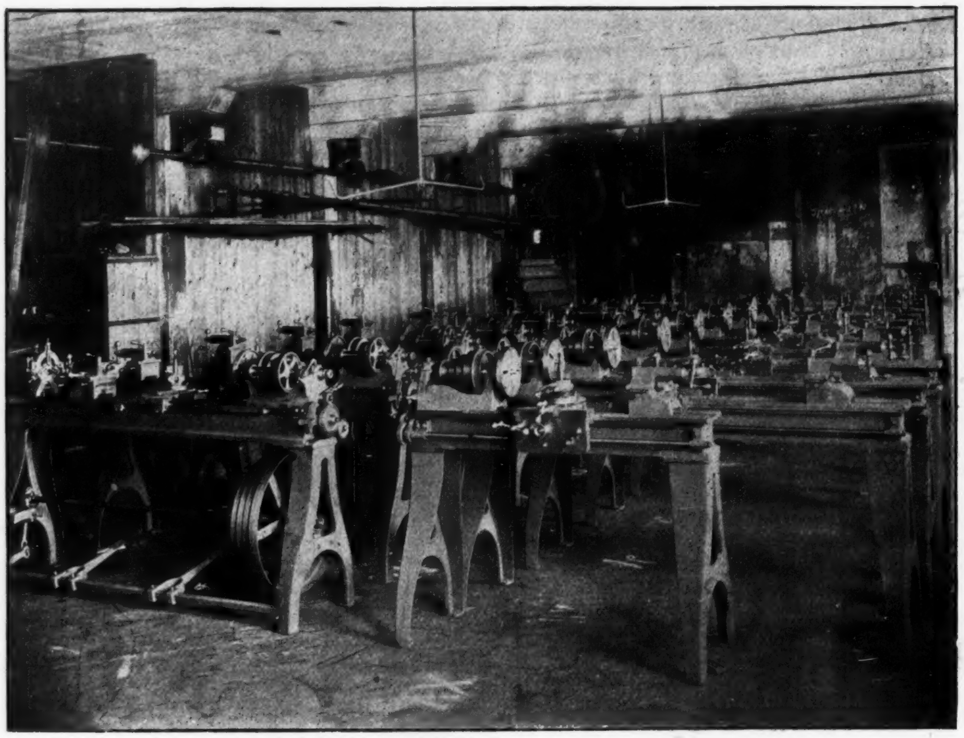
This is a new edition of an old work. If one has difficulty in making neat looking titles on his drawings it is a good book to have; otherwise we should recommend him to adopt the plain Gothic style. By Cromwell's system the sheet is divided into squares, and by their aid the letters are made entirely with the right-line pen and triangle.

The Industrial Library, No. 1. The Elementary Principles of Machine Design. By J. G. A. Meyer. 90 pages, 12mo, illustrated. Issued bi-monthly by the Industrial Publication Co., New York. Price, 25 cents each.

The first number of this series treats of connecting rods, piston rods, pistons, cotter joints and wrenches, and apparently is made up of parts of Meyer's machine design in a condensed form, of which we have already given favorable mention.

TWELVE-INCH ENGINE LATHE.

THE illustration herewith shows a line of 12-inch engine lathes manufactured by the W. C. Young Mfg. Co., of Worcester, Mass. They build them in large lots and all styles, and warrant them in all particulars. The demand has been so great and goods have given such satisfaction, they are soon to bring out a 14-inch lathe which they believe will be superior to any on the market.—*Adv.*



A LOT OF 12-INCH LATHES—W. C. YOUNG & CO., WORCESTER, MASS.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

FRANK KNEELAND MACHINE CO., Pittsburg, Pa. Catalog of rolling mill machinery, including rolls, roll turning lathes, heavy shears, cold saws, cranes, etc. 64 pages, 8¼ x 10 inches.

This is one of the handsomest catalogs which has recently come to this office, both in the excellence of the illustrations and the appearance of the text. All who are dealing with this class of machinery will doubtless find this catalog of considerable interest and value.

THE Q AND C COMPANY, Chicago, Ill. Catalog of cold metal sawing machines. 24 pages, standard size, 9 x 12 inches.

This catalog describes the well known types of shop saws made by this company, in which ordinary saw blades are used. It also describes and illustrates a circular shop saw, portable rail saws, besides various types of heavier saws designed for cutting off beams, steel casting work and for various other purposes.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio, and 99 Reade street, New York. Illustrated price list of twist drills.

A small pamphlet containing lists of standard drills, oil tube drills, combined drill and countersink, self-feeding and expansion reamers. The stock now carried at the New York office comprises the complete line, and all regular orders can be filled at sight.

MANUFACTURERS' NOTES.

AT the recent Brussels Exposition, in the machine-tool section, but two American firms and one foreign firm were awarded the "Grand Prix." They were Brown & Sharpe Mfg. Co., The Pratt & Whitney Co., and Le Progres Industriel, of Brussels, Belgium.

MR. J. W. CARREL, formerly with the Davis & Egan Machine Tool Co., has accepted a position as salesman for Messrs. Dawson & Goodwin, of Chicago.

THE L. S. STARRETT CO., Athol, Mass., write that they expected to have had their new 112-page catalogue, showing new goods and change in the list prices of their combination squares, ready to send out November 1st, but it was delayed, and will be ready about December 1st. For the present they quote 50 per cent. off from their reduced price list of combination squares, but cannot guarantee this extremely low price to continue long. They also call attention to the fact that they will allow a discount of 40 per cent. on their steel rules.

MESSRS. A. W. CHESTERTON & CO., 49 India street, Boston, are introducing to their trade a new sheet packing called "rubberbestos," composed of rubber and asbestos, a composition long sought after, but never successfully combined until now. It is claimed that it makes a joint instantly, does not have to be followed up, and can be used many times over. The asbestos combined with the rubber makes it tough and durable, and practically heat proof. A sample will be sent upon application.

THE LIDGERWOOD MFG. CO. have perfected a new hoisting engine which is known as the Lidgerwood safety derrick engine, patented. A double drum engine, with two 6¼ x 8 cylinders, is now on the floor of the Lidgerwood Mfg. Co.'s warerooms at 96 Liberty street, this city, where contractors and others are invited to call and examine it.

CURTIS & CURTIS, of Bridgeport, Conn., announce that they have made improvements in their No. 116 power pipe cutting and threading machine, which have not only increased its efficiency, but enable them to sell it at a reduced price.

DIETZ, SCHUMACHER & BOYE have decided to go forward with the building of their new factory, on the corner of Queen City avenue and Buck Street, Cincinnati, and have already let the contract for the stone-work. The building is to be of stone and brick, 90 x 180 feet, and will be pushed forward as rapidly as possible. They hope to occupy it by spring.

THE BIGNALL & KEELER MFG. CO., Edwardsville, Ill., report a good demand for their Peerless and Duplex pipe threading and cutting machines. Their recent sales number 15 machines to well-known firms, foreign and American, including two machines to the United States government.

THE DIAMOND MACHINE CO., of Providence, report an increase in their business, with a good volume of foreign orders. They have made several large shipments of their ball case grinder to Austria and Germany recently, and are at work on an order for surface grinders for England. The universal grinder is finding large sale both in this country and abroad.

BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

Wanted: A molding machine for globe valves and general cast brass fittings; *not* hydraulic nor compressed air drive. Also a small hydraulic ram for driving in and out locomotive wrist-pins and the like (not crank-pins; cross-head pins). ROBERT GRIMSHAW.
Dresden, Alstadt, Germany.

MACHINERY'S EDUCATIONAL DEPARTMENT.

LOUIS ROUILLION, B. S., DIRECTOR.

HOW YOUNG MECHANICS CAN ADVANCE—A COURSE IN MECHANICAL DRAWING OPEN TO ALL SUBSCRIBERS TO MACHINERY AT A PRICE WHICH BARELY COVERS THE COST OF INSTRUCTION.

Since the inception of MACHINERY we have endeavored to present in every issue some matter of an educational character, written in simple language and intended particularly for those who have not received a technical education. These articles were in a measure only the preparation for an educational work which we have long had in view that will enable young mechanics, and others who so desire, to obtain personal instruction at home in certain necessary branches, and to acquire at a nominal outlay the knowledge necessary to obtain positions where they can earn more money.

This work has now been undertaken by MACHINERY without any expectation of profit, at a charge sufficient only to cover the actual cost of instruction and material required for the course, and will be under the personal charge of Mr. Louis Rouillion, widely known as a thoroughly practical instructor in both day and evening mechanical schools, whose warm interest in the cause of education has materially assisted us to begin the undertaking.

The first branch to be taken up, because of its greater value and interest to mechanics, will be Mechanical Drawing; but whenever a sufficient number of subscribers to MACHINERY express a desire to begin the study of any germane subject, we will then arrange a course of instruction thereon.

HOW TO ENROLL.

Any one whose name is on the subscription list to MACHINERY is eligible to take a course in the Educational Department. To begin, it is necessary only to send us your name and address, with a money order for $2.35, in return for which we will forward you post paid the following necessary material:

	Price.
Text book on Mechanical Drawing	$1.25
Twenty instruction tickets	1.00
Thirty large printed envelopes, suitable for mailing the drawing plates; instructions, etc.	.20
Postage on the above	.10
Total	$2.55

The discount we obtain on the text book enables us to furnish the whole for $2.35. Those who do not find it convenient to send $2.35 can send us, instead, seven new subscribers to MACHINERY at $1.00 each. They must be new subscribers, not renewals.

THE DRAWING OUTFIT.

In order to do the work of the course properly, the student should have a good set of drawing instruments and other necessary materials. By purchasing in large quantities we are able to furnish the following outfit to those who desire it, for $3.40. When sent by mail, fifty-six cents must be added for postage, but to points near New York it can probably be sent cheaper by express. The weight is 56 ounces.

- Compasses, 5½ inches, with needle point; pen, pencil and lengthening bar.
- Drawing pen, 4½ inches.
- T-square, 24-inch blade.
- 45-degree triangle, 9 inches.
- 30 and 60 degree triangle, 9 inches.
- Scroll.
- Dixon's V. H. pencil.
- 12-inch boxwood scale, flat, graduated to 1-16 inch the entire length.
- Bottle of liquid India ink.
- Four tacks.
- Pencil and ink eraser.
- 20 sheets drawing paper, 11 x 15 inches.

These are not cheap instruments, but are thoroughly well made in every respect, with steel joints, needle points, etc., and the outfit would ordinarily cost between $6.00 and $7.00 in New York. We will not sell them to any person who is not on our roll of students. Those who do not find it convenient to send $3.40 can send us, instead, ten new subscribers to MACHINERY at $1.00 each, and the postage 56 cents, if they wish the set sent by mail. These must be new subscribers, not renewals.

A drawing-board about 16 x 23 inches will also be necessary; but as the expense of shipment will be considerable, students can usually make these themselves for less than we can deliver them for.

THE CORRESPONDENCE SYSTEM ADOPTED.

The correspondence system has been shown beyond question to be the best method for educating men who cannot afford the time and money to leave home and employment. By this system it is possible to furnish personal instruction to each student, which is much more efficient than that given at an evening school where one instructor has a large number of students and can spend but a few moments with each one. A student can also work as many hours or as few as he desires; he can work every day in the week if his duties permit, and he can advance as he is able without being held back by others who are less intelligent. On the other hand, if he is naturally backward he can go along slowly without feeling that he must work under pressure in order to keep up with his class; and he can ask questions privately by letter, which he would often hesitate to ask in the class-room where many of his associates might be more advanced than he.

METHOD AND COST OF INSTRUCTION.

When the student has secured his drawing instruments, book, and sheet of instructions, he can begin work at once, sending in the first plate for correction as soon as it has been drawn. The only expense in addition to the tickets and the cost of the materials will be the postage on the plates, which will amount to two cents per plate each way.

The course in Mechanical Drawing will comprise 29 plates, which are included in the text book we furnish. The student is required to draw each one of these plates in its order and to mail it to the instructor in the addressed envelope which we forward him, with one or more of the instruction tickets as may be required, and a stamped envelope for the return of the plate. The latter will then be carefully examined by the instructor, the errors pointed out and a letter written the student giving such instuctions as the work indicates that he needs. For convenience, we supply twenty tickets for one dollar, which are good till used on any course. One ticket each will cover the cost of correcting twenty of the twenty-nine plates; the remaining nine requiring two tickets each. Five of these double-priced plates come at first, and the remaining four at the end of the course. Each time that a plate is sent to the instructor to be corrected, the necessary ticket or tickets must accompany it. For special instruction on any point connected with the work the student must enclose one or two tickets for the reply, according to the amount of information asked for, together with a stamped return envelope.

DESCRIPTION OF THE COURSE.

The course in Mechanical Drawing will represent the result of a number of years' work with day and evening classes, mostly of working mechanics, by Mr. Rouillion. The text book used is published by L. Prang & Co., of Boston. It is a revision, with additions, of Mr. Rouillion's articles upon Mechanical Drawing which appeared serially in MACHINERY, and is regarded as the best short work on the subject.

The complete course includes 29 drawing plates, which ensure the student a thorough drill in the use of the instruments, projections, developments, and the general principles of mechanical drawing, besides enough practice on working drawings to enable him to make neat drawings and to read them understandingly. Particular attention is paid to lettering. The whole course requires about 300 hours to be completed by the average student, and we unhesitatingly pronounce it to be the best course in mechanical drawing that has ever been undertaken by the correspondence method.

Address, Educational Department, MACHINERY, 411-413 Pearl St., New York.